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LORAN-C Aviation Monitor (LORMON) Interfaced With VOR Remote Maintenance Monitoring System: Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Report

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NOTICE

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16. Abstract

This report addresses the Operational Test and Evaluation (OT&E) Integration and OT&E Operational Testing conducted in support of the Loran-C Aviation Monitor (LORMON). The LORMON was tested with the second generation Very High Frequency Omnidirectional Range (VOR) Remote Maintenance Monitoring System (RMMS). The test suite consisted of the following equipment: LORMON, second generation VOR, Tactical Air Navigation (TACAN), and Remote Monitor and Control Processing Unit Type F (RMC-F). A preproduction Electronic Engineering Modification (EEM) kit was installed in the VOR equipment so that communications with the LORMON would be possible. The modification kit included a wiring harness, and an additional circuit card assembly for the Facilities Central Processing Unit (FCPU) of the VOR. New firmware was installed at both the FCPU and RMC-F. All testing was conducted at the Federal Aviation Administration (FAA) Technical Center.

Analysis of the results indicate that the LORMON and modified VOR RMMS did not meet all the requirements of NAS-SS-1000, LORMON specifications, or LORMON interface control document. One item was identified as deployment critical, 22 items were identified as critical, and 20 items were identified as noncritical.

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EXECUTIVE SUMMARY

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Each of the maintenance commands pertaining to the LORMON were executed at least once from each of the input-output terminal, teletype/printer, and dial-up modem ports of the FCPU and RMC-F. Commands pertaining to the VOR, TACAN, and RMMS were executed at least once from some port in the system. When testing National Airspace System (NAS) Requirements pertaining to a time requirement, the commands were issued with and without a Loran data archive download in progress. This was done to ensure that the transfer of Loran archive data did not effect system timing. The port used to test each command was recorded and appears in this report.

Analysis of the results indicate that the LORMON and modified VOR RMMS did not meet all the requirements of NAS-SS-1000, LORMON Specifications, or LORMON interface control document. One item was identified as deployment critical, 22 items were identified as critical, and 20 items were identified as noncritical. The cable strain relief used on the preproduction wiring harness, when installed, will short out a circuit breaker. This is a serious safety hazard and must be corrected in the production kit. Those items defined as critical need to be fixed while noncritical items need to be reviewed. Items identified as critical generally effect only the LORMON and do not effect the proper operation of the VOR or TACAN.

1. INTRODUCTION.

1.1 PURPOSE.

This report addresses the Operational Test and Evaluation (OT&E) Integration and OT&E Operational Testing conducted in support of the Loran-C Aviation Monitor (LORMON). Integration and Operational Testing were conducted between the LORMON and the Very High Frequency Omnidirectional Range (VOR) Remote Maintenance Monitoring System (RMMS).

1.2 BACKGROUND.

The Federal Aviation Administration (FAA) has approved Loran-C as a navigation source for standard instrument approaches. In order to support approaches using Loran-C, special monitors will be needed. The special monitors are known as Loran-C Aviation Monitors. The monitors will measure the signal environment, provide signal status, and archive data for the determination of area calibration values. The correction values are necessary to meet the accuracy requirements for nonprecision approaches. To reduce the cost of communicating with the LORMONs, it was decided to interface the monitors with the RMMS for the second generation VOR. The LORMONs will therefore only be colocated in existing second generation VOR facilities. The RMMS for the second generation VOR is different from most FAA systems and does not use the National Airspace System (NAS) MD-790 protocol. The term VOR RMMS will be used throughout this document to note this difference.

In order to add LORMON information to the VOR RMMS system, changes were required to the Facility Central Processing Unit (FCPU), Remote Monitor and Control Processing Unit Type F (RMC-F) and Remote Monitor and Control Processing Unit Type C (RMC-C). A contract was issued to Wilcox Electric to modify the existing VOR RMMS so that it would communicate with the LORMON. The original contract also required adding an interface to the Cardion Distance Measuring Equipment (DME) and adding three additional audio channels. The requirement for the additional audio channels was later removed from the specification. This was done in a memorandum, dated September 7, 1990, from the Associate Program Manager Engineering (APME) for Loran-C to the contracting specialist. Changes were made in the FCPU card firmware, and an FCPU expansion card was added to provide for expanded memory. These changes were reflected in a draft Electronic Equipment Modification (EEM). Associated firmware changes for the RMC-F and RMC-C are also included in the same EEM. If a LORMON or Cardion DME is added to a VOR site, the FCPU, RMC-F and RMC-C, communicating with the site, must install the modification kit identified in the appropriate EEM (reference Document No. 8).

Testing of the LORMON was started in September 1988, with the delivery of the monitor. This early testing focused on basic monitor functions in a stand-alone configuration. Testing of the FCPU port on the LORMON was limited to testing with a Technical Center developed FCPU simulator and protocol analyzer. Official OT&E integration testing was not started until September 1990. Integration testing was delayed until the modified FCPU and RMC-F cards were received. Seven versions of LORMON firmware and four versions of FCPU and RMC-F firmware have been tested. Various combinations of LORMON, FCPU and RMC-F firmware have also been tested. The latest testing was conducted on the firmware intended for deployment and took place between November 9, 1992, and January 15, 1993. All integration testing was conducted in accordance with "Loran Aviation Monitor With Remote Maintenance Monitor System, NAS OT&E/Integration Test Plan" except as noted.

Results of previous testing on the effects of installing a LORMON at a VORTAC site and evaluating the FCPU port of the LORMON can be found in other documents. The results of installing a LORMON at the VORTAC is reported in an FAA Technical Note titled "Loran-C Antenna Installation," DOT/FAA/CT-TN88/37. Results of evaluating the FCPU port are reported in an FAA Technical Note titled "Loran C Monitor: Facilities Central Processing Unit (FCPU) Port Evaluation," DOT/FAA/CT-TN89/57.

2. REFERENCE DOCUMENTS.

1. Master Test Plan, Loran-C Aviation Monitor, May 23, 1988

2. Interface Control Document, FAA ICD98390-8000

3. VORTAC/LORAN Operator Interface, WPN DR098390-8000

4. NAS-SS-1000, NAS System Specification, Functional and Performance Requirements for the National Airspace System:

   a. Volume I, General
   b. Volume III, Ground-to-Air Element
   c. Volume V, Maintenance and Operations Support Element

5. Loran-C Monitor Specification, FAA-E-2762

6. Loran-C Antenna Installation, Norman Beauregard and Robert Erikson, DOT/FAA/CT-TN88/37, September 1988.

7. Loran Aviation Monitor With Remote Maintenance Monitor System, NAS OT&E/Integration Test Plan, FAA Technical Center

8. 6820.6 CHG XXX, Navigational Aids Facilities And Equipment Modification Handbook - VOR, VOR/DME, VORTAC, Chapter XX. Install Type FA-10232 Loran-C/FA-9783 Cardion DME to FCPU Interface, Revision H Firmware, Remote Monitor And Control Unit-2400B (RMC-C); Revision K Firmware, Remote Monitor and Control Unit - 150B (RMC-F); Revision A Firmware, Expansion Facility Central Processing Unit (FCPU); FA-9996 Equipment

9. Loran C Monitor: Facilities Central Processing Unit (FCPU) Port Evaluation, Frank Garufi, DOT/FAA/CT-TN89/57, March 1990.

3. INTEGRATION TESTING - OVERVIEW.

3.1 TEST AND EVALUATION PHILOSOPHY.

Integration testing was conducted to verify that the LORMON and interfaces were in compliance with the applicable design specification. An assessment of operational issues was also conducted.

Since the VOR RMMS and Cardion DME are existing systems, AOS-240 is responsible for their modification and maintenance. The FAA Technical Center testing focused on testing the integration of the LORMON with the VOR RMMS. Addition of the LORMON did require changes to the VOR RMMS network. Both the interface protocol used to transfer data between various points in the network and the screens used to request and display information were changed. The basic interface protocol remained unchanged. Existing unused bits were defined for LORMON information and provisions for additional data types were added. This required the addition of new packet types but did not change the packet size or interface protocol. Screens used to request and display information required adding the ability to select LORMON information. All LORMON information was added as new screens except for one or two screens which only needed additional information added to the existing data. Since these changes should not effect the transfer and display of VOR, TACAN, and DME information, only basic communications with the VOR and TACAN were tested. In particular, testing verified that LORMON information could be correctly transmitted through the FCPU to the RMC-F, and that transmission of VOR and TACAN data through the same system was not adversely affected by the LORMON. Testing of the Cardion DME interface was conducted by AOS-240 and not retested by the Technical Center. Field operational verification testing (FOVT) had already shown that these systems operate with the modified FCPU, RMC-F, and RMC-C.

Sources of test requirements for the integration testing were obtained from:

a. Loran-C Master Test Plan
b. NAS-SS-1000
c. Loran-C Monitor Specification FAA-E-2762
d. FAA Technical Center field experience with Loran and RMMS (derived requirements).

Integration testing was based on system requirements found in NAS-SS-1000, the LORMON specification, and knowledge of the entire system. Due to the various equipments which interconnect with or use information supplied by the FCPU card, determining actual requirements for integration testing was not straight forward. In many cases, issuing one command resulted in testing several NAS-SS-1000 requirements. For traceability, the individual system requirements will be listed with the test condition where actual testing took place. These requirements are included in the analysis section.

The integration test plan was based on the NAS-SS-1000 requirements dated December 1986. Subsequent to the development of the integration test plan several of the NAS requirements pertaining to the LORMON have been changed. Changes to the NAS requirements will be noted in the analysis section of this report.

Table 3.1-1 is a summary of the various points of entry into the VOR RMMS network and what can be controlled or affected at each point. The left column shows the parameter or equipment affected. The other columns show if the point of entry, listed at the top of each column, will affect the parameter listed in the left column. Under the heading of data bus loading, each column shows how many specific types of equipment can be controlled from the point of entry identified at the top of the column. The number of equipments listed in the table are based on the RMMS system limits and not for typical configurations found in the field. Configurations found in the field will vary in number and types of equipment. More than 94 commands may be used to communicate with each site. Many of the commands are multipurpose and control several types of equipment at a VOR site (i.e., VOR, TACAN, and LORMON). Each of the commands may be issued at any of the three ports of entry (input/output terminal (IOT), teletype (TTY)/printer, and dial-up modem) on the FCPU, RMC-F, and RMC-C. The length of time required for testing would be impractical if each command was tested on each specific type of equipment, and from each point of entry. Some assumptions were made to reduce the number of tests conducted during Integration Testing.

TABLE 3.1-1. POINT OF ENTRY/PARAMETERS AFFECTED

PARAMETER	LORMON IOT	FCPU	RMC-F	RMC-C
Equipment Selection				
LORMON	Y	Y	Y	Y
VORTAC	N	Y	Y	Y
Cardion DME	N	Y	Y	Y
RMC-F	N	N	Y	Y
RMC-C	N	N	N	Y
Security	Y	Y	Y	Y
Commands/Data Transfer	Y	Y	Y	Y
Data Bus Loading				
LORMON	1	1	8	128
VORTAC	0	1	8	128
Cardion DME	0	1	8	128
RMC-F	0	0	1	16
RMC-C	0	0	0	1
Time To Report Status	Y	Y	Y	Y

Notes:

1. Y - Item in left column may be affected.
2. N - Item in left column will not be affected.
3. If a number appears in column, it identifies the number of equipments that could be affected.

3.2 TEST AND EVALUATION APPROACH AND CONCEPT.

3.2.1 System Configuration.

Figure 3.2.1-1 shows a top level system configuration for the LORMON including the RMMS. For discussion purposes, the configuration shown in figure 3.2.1-1 will be called the VOR RMMS network. It should be noted that the VOR RMMS network is only a small part of the FAA's RMMS. The VOR RMMS network is almost totally separate from the rest of the FAA's RMMS system and uses a different interface specification. In a typical installation, the VOR facility reports to a RMC-F which in turn reports to a RMC-C. A single RMC-F may receive information from up to eight VOR sites. The RMC-C may receive information from up to 64 RMC-Fs. If the system is fully loaded, 512 VOR sites could be reporting to a single RMC-C. It is technically possible for each VOR site to be equipped with a LORMON. In practice, the VOR RMMS network actually implemented in the field does not come close to the maximum theoretical capability of the network. For example, only a few RMC-Cs have been fielded and a total of only 196 LORMONs will be installed throughout the United States.

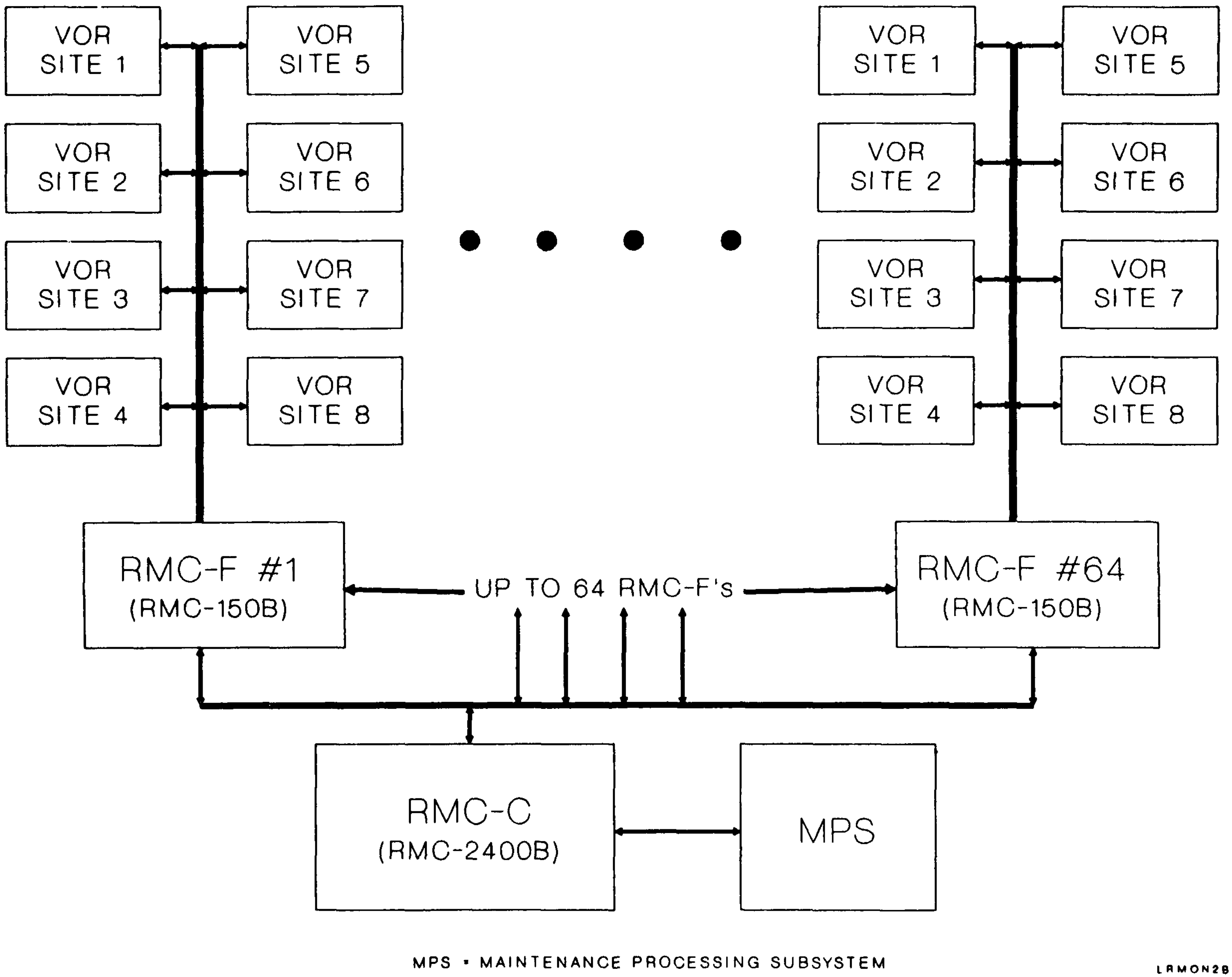


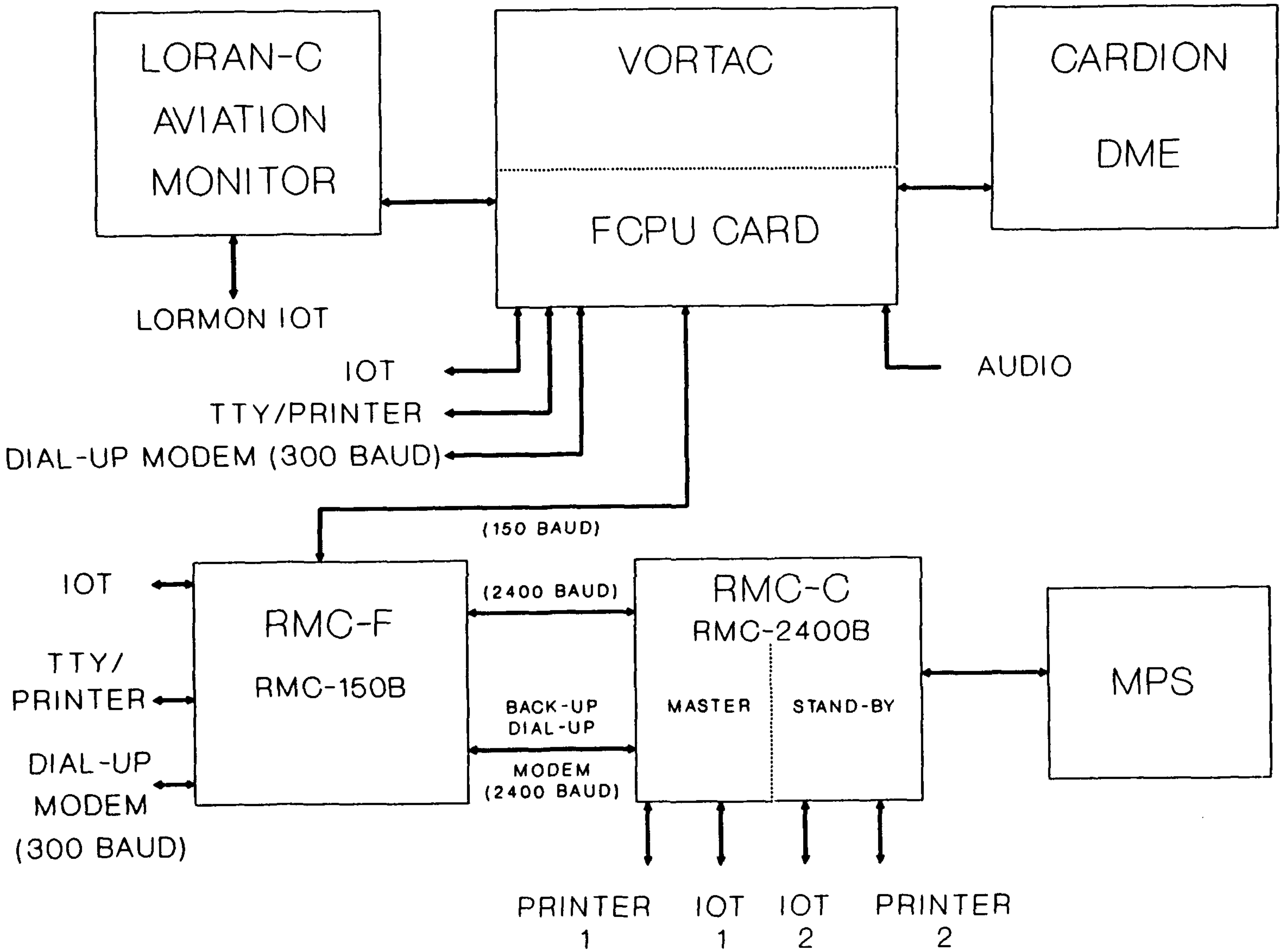
FIGURE 3.2.1-1. OVERVIEW VOR RMMS NETWORK

Figure 3.2.1-2 shows a more detailed system interconnection for a single path. Integration Testing conducted at the Technical Center only used a subset of the entire VOR RMMS network. Figure 3.2.1-3 shows the subset used during Integration Testing. The configuration was limited to one LORMON, one VOR, and one TACAN reporting to one FCPU which reported to a single RMC-F. No special test equipment was required.

The addition of the LORMON and Cardion DME to the VOR RMMS network required changes to the FCPU, RMC-F, and RMC-C. These changes required new firmware for the FCPU, RMC-F, and RMC-C. In addition to the new firmware, the FCPU required additional memory and communication ports. Data transmission protocol from the FCPU to the RMC-F and from the RMC-F to RMC-C required only minor changes. The data is transferred in packets. The packet protocol used to transfer information over the VOR RMMS network remained basically unchanged as a result of adding additional equipment to the network. The addition of the Cardion DME required no changes to the packet protocol to transfer information between the FCPU and the RMC-F or the RMC-F and RMC-C. No changes were required because the VOR RMMS network already supported a DME. Therefore, all necessary screens and data transfers already exist. However, software and hardware changes were required at the FCPU level to communicate with the Cardion DME. It is at the FCPU level that the RMMS commands are changed into instructions that the particular equipment can decode.

The addition of the LORMON required more changes to the VOR RMMS network. For the most part, existing screens at the FCPU, RMC-F, and RMC-C could not be used for the LORMON. New screens had to be generated as well as the modification of several existing screens to support the LORMON. The new and modified screens required changes at the FCPU, RMC-F, and RMC-C. To support the LORMON, several existing bits in the packet protocol had to be redefined. Changes to the FCPU included an expansion card to increase memory size and the addition of interfaces for the Cardion DME and LORMON. No major modifications to the basic VORTAC system were required. The only hardware modifications were the addition of a new FCPU expansion card for the VORTAC equipment and the addition of three cables.

Changes to the RMC-F and RMC-C equipment to support the LORMON and Cardion DME required only firmware changes. No hardware changes were required for the RMC-F and RMC-C.



MPS = MAINTENANCE PROCESSING SUBSYSTEM

LRMONIC1.CHT

FIGURE 3.2.1-2. DETAILED SYSTEM INTERCONNECT

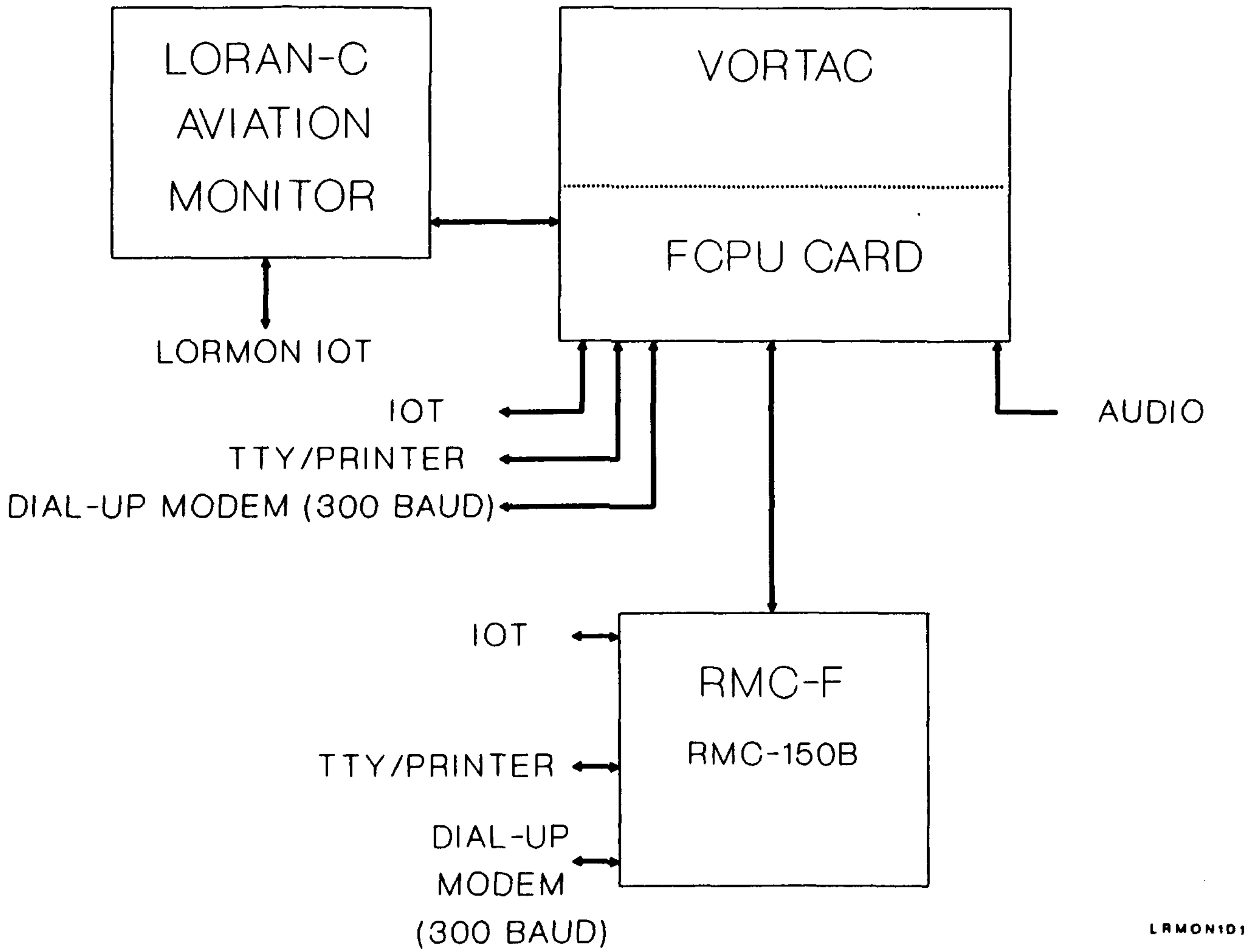


FIGURE 3.2.1-3. INTEGRATION TEST SYSTEM INTERCONNECTION

The FCPU and RMC-F preproduction modification kits were installed in equipment located at the FAA Technical Center's Experimental VOR/TACAN (VORTAC). Installation of the modifications were conducted using guidance provided in the draft EEM (reference document No. 8). No number had been assigned to the EEM as of our testing. The Experimental VORTAC is located in building 196. The RMC-F equipment was also located in the same VORTAC building. In a typical installation, the RMC-F would be located at a remote site and not in the same building as the FCPU. The configuration present at the Technical Center makes it possible to observe the LORMON, VORTAC, and RMC-F equipment when requesting information or issuing commands from the various terminal ports on the equipment. The site has two phone lines which allowed testing of the dial-up modem ports from building 196. The modification kits were installed and operational by November 27, 1990. Official integration testing commenced on November 27, 1990, and was concluded on January 4, 1991. As a result of testing, modifications to the system were required. Formal Integration Testing, with a modified system (preproduction), was restarted November 9, 1992, and concluded on January 15, 1993. As indicated in the test plan, only the following equipments were included in the FAA Technical Center's test bed: VOR, TACAN, LORMON, FCPU, and RMC-F.

The following equipment was tested:

a. Second Generation VOR/TAC FA-9996

VOR		
TACAN		
FCPU	Rev A.	Dated 10/05/92
FCPU EXP. Card	Rev A.	Dated 10/05/92
RMC-F	Rev K.	Dated 10/22/92

1. The Second Generation equipment had the following changes from order 6820.6 installed:

   2, 4, 6, 7, 8, 9, 10, 12, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 32, 34, 38, 39, 40, 41, 43, 47, 48, 50, 53, 54, 57, 61, 62, 72, 73, 77, 80, 88, 112, 116, 119, 122, 126, and 127.

   Those changes not installed were related to the environmental sensors or standby generator which are not installed at the Experimental VORTAC.

b. Loran Aviation Monitor FA-10232 Rev 1.11

3.2.2 Basic System Operation.

The VOR RMMS network operates in a polled mode. Polls may be initiated from the FCPU, RMC-F, or the RMC-C. The request may come from the IOT, TTY/PRINTER, or dial-up modem ports. Each navigational aid on the VOR RMMS network is polled once per second for status. The status information is available at the FCPU, RMC-F, and RMC-C. The RMC-C automatically sends master time to each navigational aid in the VOR RMMS network. FAA personnel may access and control any selected navigational aid (site) downstream from the point of entry into the VOR RMMS network. Entry into the VOR RMMS network may be accomplished at the FCPU, RMC-F, and RMC-C. The actual interface may be through an IOT, dial-up modem, or TTY/PRINTER located at each node in the network. Security procedures are implemented in the FCPU, RMC-F, and RMC-C equipment in order to limit system access to only authorized personnel. Security for the IOT port, located on the front panel of the LORMON, is provided by the LORMON. Data exchange includes equipment status, data transfers, and information necessary to troubleshoot the equipment.

The addition of the LORMON to the VOR RMMS network will greatly increase the amount of data transferred over the network. In order to allow other users access to a subsystem when downloading LORMON archive data, the user requesting that data will be logged off the subsystem once the transfer begins. The LORMON archive data transferred will be used to calculate area calibration values.

4. TEST CONDITIONS.

The Integration Test Plan identified 14 different types of testing to be conducted on the VOR RMMS network. This section identifies each type of test and test procedure. Some test procedures were modified during the actual testing. The variations will be identified were applicable. Not specifically identified in the test plan, but included in this report, are comments about the preproduction installation kit.

The number in parenthesis at the end of the test title identifies the paragraph number from the Integration Test Plan that identifies the test procedure.

Testing of the RMC-C and testing the RMC-F with multiple VOR sites was not conducted by the Technical Center. Limited testing was conducted by AOS-240 in Oklahoma City, OK. The testing included an RMC-C and a fully loaded RMC-F using one operational VOR facility and simulating seven other VOR facilities. Several random commands were issued.

4.1 TEST 1. EQUIPMENT SHUTDOWN/TIME TO REPORT STATUS (3.2.3.1.3.1).

1. While properly logged on at the RMC-F IOT, the BLACKOUT command ("M;2A" set) was issued. The test plan called for using the SHUTDOWN command ("L;2"). The "M2" command facilitated testing since BLACKOUT shuts down both the VOR and TACAN with just one command.

2. The shutdown of both the VOR and TACAN equipment was verified by observing the status lights located on the front panel of the equipment. During shutdown, the green light is turned off.

3. The time was measured between executing the command and receiving an alarm or alert back to the RMC-F. Alarm or alert status was monitored by watching the equipment labels going into inverse video on the IOT.

4. The time was recorded between issuing the command and observing a response.

5. The VOR and TACAN equipment was turned back on by issuing the BLACKOUT CLEAR ("M;2B") command.

6. Steps 1 through 5 were repeated 10 times.

4.2 TEST 2. TIME TO REPORT LORMON OPERATIONAL STATUS TO CONTROL POINT (3.2.3.1.3.3).

1. The operator was properly logged on at the RMC-F IOT.

2. Verified that the LORMON was properly tracking without any alarms.

3. The LORMON offset parameter was changed so that the monitor would have a position alarm. This was accomplished by using the J2 screen and was a change from the original test plan. The original test plan called for disconnecting the antenna from the LORMON.

4. The time between the LORMON showing an alarm light on the front panel and the "L" on the RMC-F IOT showing inverse video was measured.

5. After the measurement was recorded, the LORMON was returned to a nonalarm condition by changing the monitor offset parameter back to the original value.

6. Steps 1 through 5 were repeated five times.

7. Steps 1 through 6 were repeated while downloading Loran archive data to the RMC-F dial-up port.

4.3 TEST 3. TIME TO DETECT AND PRESENT: ALARMS AND STATE CHANGES (3.2.3.1.4.2).

1. The system under test (i.e., VOR, TACAN, and LORMON) was observed to be in a nonalarm condition. If the system was in alarm, the system was returned to a nonalarm state before proceeding with the test. The observation was made at the RMC-F IOT.

2. The state of the navigation equipment was changed. The TACAN state change was initiated by changing the active monitor. One of the MONITOR CONTROLLER ("L;7TA", "L;7TB") commands was issued to change the active monitor. An A was for monitor 1 and B for monitor 2. The VOR state change was initiated by turning its front panel switch from Normal to By-Pass mode of operation. The LORMON is a single monitor system, therefore, it was not possible to force a state change by switching active monitors. Procedures used in Test 2 created an alarm for the LORMON, and thus the results were used to demonstrate compliance with the requirements of this section. A redundant separate test was not run to satisfy Test 3 requirements.

3. Change of state was observed on the RMC-F IOT equipment status line. When the VOR or TACAN state was changed or the LORMON went into alarm, the system would go into alert showing an inverse video "V", "T", or "L". The VOR test procedure in step 2 varied from the test plan. Unlike the TACAN equipment, changing the VOR active monitor did not cause an inverse video "V". There was no

observable indication of the state change other than observing the RMC-F IOT G screen. Confirming the state change by viewing the G screen requires the system to process additional commands and inflates the actual time to detect and present the state change. Using the switch on the VOR front panel to change its state from Normal to By-Pass did cause an inverse video "V" to indicate the equipment changed state.

The time from when the equipment had an alarm or changed state to when the event was reported at the RMC-F was measured and recorded.

The test plan required repeating steps 1 through 3, except the equipment under test, should be forced into an alarm condition rather than causing a state change. This was not done as part of Test 3. To avoid redundant testing, this observation was made during Test 4. The control commands used in Test 4 to measure execution times also caused the system to go into a state of alarm. In Test 4, the control commands must execute within 5 seconds. The NAS-SS-1000 requirements for Test 3 are reporting of an alarm condition within 10 seconds. If the control commands, which caused an alarm, meet the specification for Test 4, then Test 3 requirements would also be satisfied.

4. The sequence was repeated 10 times for the VOR and TACAN and 5 times for the LORMON.

5. Steps 1 through 4 were repeated while downloading Loran 4-Hour archive data to the RMC-F dial-up port.

4.4 TEST 4. CONTROL COMMAND EXECUTION TIME (3.2.3.1.4.3).

1. The operator was properly logged on at the RMC-F IOT.

2. Since testing conducted in section 4.3 would indicate if those commands could be executed and state change information displayed within the appropriate times, new commands were used for this test. All commands are different from the commands identified in the test plan. The following commands were tested:

TACAN	RESET	"L;1T"
VOR	SHUTDOWN	"L;2V"
	RESTART	"L;3V"
LORMON	RESET	"L;1L"

3. The time was recorded from when the command was issued at the RMC-F IOT to when the command was executed. Execution of the command was verified by observing the status lights located on the front panel of the equipment.

4. The system was returned to a Normal state.

5. Steps 1 through 4 were repeated 10 times for the VOR, 10 times for the TACAN, and 10 times for the LORMON.

6. Steps 1 through 5 were repeated while Loran 4-Hour archive data was being downloaded to the RMC-F dial-up port.

4.5 TEST 5. PRESENTATION OF REQUESTED INFORMATION (3.2.3.1.4.4).

1. The operator was properly logged on at the RMC-F IOT.

2. The CERT TEST "K;2x" command was executed for the VOR, TACAN, and LORMON. "x" was replaced with "V" for the VOR, "T" for the TACAN, and "L" for the LORMON. This ensured that CERT data would be present.

3. The following commands were executed to retrieve the results of the CERT TESTs:

"DV1"	CERT DATA VOR MONITOR 1
"DV2"	CERT DATA VOR MONITOR 2
"EV"	CERT DATA VOR TRANSMITTER
"I;5"	VOR DIAGNOSTICS
"DT1"	CERT DATA TACAN MONITOR 1
"DT2"	CERT DATA TACAN MONITOR 2
"ET"	CERT DATA TACAN TRANSMITTER
"DL"	CERT DATA LORAN MONITOR

4. The time from when the command was executed to when the data appeared on the screen was measured.

5. The time delay was recorded.

6. The test plan called for 10 repetitions for each of the screens listed in step 3. The presentation of 80 "results" screens were not measured. A total of 21 "results" screens were measured. The screens were a mix of the screens listed in step 3.

7. Steps 3 through 5 were repeated with Loran 4-Hour archive data being downloaded to the RMC-F dial-up port. The time delays of 14 "results" screens were measured.

4.6 TEST 6. ACKNOWLEDGEMENT OF TEST COMMAND (3.2.3.1.4.5).

1. The operator was properly logged on at the RMC-F IOT.

2. The operator verified that the system was not currently executing any commands. This was viewed on the System State screen (G screen).

3. Five trials of each command listed below were executed:

"K;2V;G"	VOR CERT TEST
"K;8;G"	GROUND CHECK VOR
"K;2T;G"	TACAN CERT TEST
"K;15;G"	TRANS TEST TAC/DME
"K;2L;G"	LORAN CERT TEST
"K;5L"	FAULT ISOLATE LORAN (Removed from test due to loss of communication during fault isolate.)
"K;19;G"	TEST LORAN

4. The time from when the command was issued to when an appropriate message appeared on the System State screen (G screen) was measured. To speed the display of the G screen, it was chained to the commands in No. 3 above.

5. Recorded the value.

6. ABORT TEST ("K;1x") was then issued where x was replaced by a "V", "T", or "L" depending on the equipment under test. The time was measured and recorded from when the command was issued to when the confirmation was made on the IOT status line.

7. Steps 1 through 6 were repeated five times for each condition. This was changed from 10 times that appeared in the test plan. This test series was conducted without downloading Loran archive data.

8. Steps 1 through 7 were repeated while downloading Loran archive data to the RMC-F dial-up port.

4.7 TEST 7. GENERAL COMMANDS (3.2.3.2).

The tests identified in this section were intended to exercise each of the commands which communicate with the LORMON, VOR, TACAN, and monitoring system. While this section refers to section 3.2.3.2 of the test plan, many other sections of the test plan also referred to section 3.2.3.2 for the actual testing. Since no special instructions are necessary to test each command, no specific test procedures have been identified. General test procedures appear below.

4.7.1 VOR - TACAN.

Each of the commands appearing in appendix A, which applied to the VOR and TACAN, were executed. Commands were randomly executed at one of the following ports: FCPU IOT, FCPU TTY/PRINTER, FCPU DIAL-UP MODEM, RMC-F IOT, RMC-F TTY/PRINTER, and RMC-F DIAL-UP MODEM. Each command was executed at least once from one of the ports in the network. Any commands which did not respond, like an unmodified system, were noted. Results were reported on the appropriate form.

4.7.2 LORMON.

Each of the commands appearing in appendix A, which applied to the LORMON, were executed. Each command was executed at the FCPU IOT, FCPU TTY/PRINTER, FCPU DIAL-UP MODEM, RMC-F IOT, RMC-F TTY/PRINTER, and RMC-F DIAL-UP MODEM. Results were reported on the appropriate form.

4.7.3 RMMS.

Each of the commands appearing in appendix A, which applied to the RMMS system, were executed. Commands were randomly executed at one of the following ports: FCPU IOT, FCPU TTY/PRINTER, FCPU DIAL-UP MODEM, RMC-F IOT, RMC-F TTY/PRINTER, and RMC-F DIAL-UP MODEM. Each command was executed at least once from one of the ports in the network. Any commands which did not respond, like an unmodified system, were noted. Results were reported on the appropriate form.

4.8 TEST 8. SUBSYSTEM STATUS REPORTS (3.2.3.2.3).

1. A printer was connected to the TTY/PRINTER port of the RMC-F. From the RMC-F Directory ("T" screen), the TTY/PRINTER port was set to print status changes ("F;3").

2. The operator was properly logged on at the RMC-F IOT.

3. Each of the following tests were performed:

   a. The VOR Monitor 1 was forced out of tolerance by lowering the "Field Intensity HI" limit (J;2V1,10 screen) to an alarm condition. The procedure changed the limit from 37.5 decibel (dB) to 35 dB. Messages printed on the TTY/PRINTER were noted. The state of the "V" on the status line of the IOT was observed and recorded. While the VOR Monitor 1 was still out of tolerance, VOR Monitor 2 was forced out of tolerance using the same procedure as for Monitor 1. The observations were recorded. The "Field Intensity HI" limit was then returned to nonalarm condition.

   b. The TACAN Monitor 1 was forced out of tolerance by lowering the "Reply Delay HI" limit ("J;2T1,2" screen) to an alarm condition. Messages printed on the TTY/PRINTER were noted. The state of the T on the status line of the IOT was observed and recorded. While the TACAN Monitor 1 was still out of tolerance, the TACAN Monitor 2 was forced out of tolerance using the same procedure as for Monitor 1. The observations were recorded. The "Reply Delay HI" limit was then returned to nonalarm condition.

   c. The LORMON was forced into an alarm condition by putting the monitor into By-Pass mode using the Monitor By-Pass Enable command ("L;6LA" screen). Messages printed on the TTY/PRINTER were noted. The state of the L on the status line of the IOT was observed and recorded. The LORMON was then returned to nonalarm condition by using the Monitor By-Pass Disable command ("L;6LB" screen).

4.9 TEST 9. LOCAL DATA FILE (3.2.3.2.4).

This requirement was interpreted to mean that the file will exist in the equipment connected to the VOR RMMS network.

1. The operator was properly logged on at the RMC-F IOT.

2. The operator requested Executive Data (B screen) from the VOR, TACAN, and LORMON. Also requested were System State (G screen) and Maintenance Alerts (H screen).

3. The operator verified that subsystem status and performance data were present.

4.10 TEST 10. FAIL SAFE DESIGN (3.2.3.3.1.6).

1. The operator was properly logged on at the FCPU IOT.

2. The operator ensured that the "L" on the FCPU screen was in Normal video.

3. Power to the LORMON was turned off (at the front panel switch) and the status of the "L" on the FCPU screen was observed and noted. The operator then tried to communicate with the LORMON (i.e., request Executive Data, B screen) and results were recorded.

4. Power to the LORMON was then switched on and the "L" on the FCPU screen was observed.

4.11 TEST 11. LORAN MONITORED PARAMETERS (3.2.3.3.2.3).

1. The operator was properly logged on at the FCPU IOT.

2. The operator requested the following screens and verified that the time differences and signal to noise ratios (S/N) were displayed to the correct resolution: B, I16, I17, I19, and I20.

3. Steps 1 and 2 were repeated with the operator logged on at the RMC-F.

4.12 TEST 12. POWER OUTAGE (3.2.3.3.2.4).

1. The operator was properly logged on at the RMC-F IOT.

2. The operator verified that the LORMON was operating properly by reviewing the B screen, Executive Data.

3. The power plug to the LORMON was removed for 30 seconds.

4. The power plug was reconnected to the LORMON.

5. Communications with the LORMON during and after the simulated power outage was attempted by accessing the B screen. The results were noted.

4.13 TEST 13. LOG-ON/SECURITY (3.2.3.4.1).

Three levels of security have been implemented in the VOR RMMS network. Each security level allows access to only certain parts of the VOR RMMS network. Two general types of testing were conducted. The first test addressed command access versus security log-on level for the VOR, TACAN, and LORMON. Only a few selected commands were tested. The second test was a detailed test to evaluate which screens were accessible versus the various levels of log-on for the LORMON.

Table 4.13-1 lists the commands that were executed during the first series of testing. The table lists a command that should be accessible for a particular security log-on level and equipment. In addition, a second command is listed which should not be accessible for the security level. The results of each test were recorded. Testing was conducted at the FCPU and RMC-F IOTs.

Table 4.13-2 lists all the commands which pertain to the LORMON. Each command was executed from the FCPU and RMC-F at the IOT, TTY/PRINTER, and dial-up modem ports. The ability to execute the command and whether the command was a read only, write only, or read/write command was recorded.

TABLE 4.13-1. VOR/TACAN/LORMON COMMANDS

(Tests performed at RMC-F IOT)

Log-on Level	Equipment Selected	Should Respond Command	Should Not Respond Command
1 2 3	VOR	B J;5V B	Changing J1 K;2V *
1 2 3	TACAN	B J;5T B	Changing J1 K;2T *
1 2 3	LORMON	B J;5L B	Changing J1 K;2L *

LEGEND

*	Unlimited access, no commands should be denied
1	Password level security
2	Lockout level security
3	Safeguard level security

TABLE 4.13-2. COMMANDS FOR LORMON SECURITY TEST

PARAMETER	NONE	SECURITY LEVEL PASS WORD	LOCK OUT	SAFE GUARD
A LORAN DIRECTORY	* N	Y	Y	Y
B MONITOR EXEC DATA	N	Y	Y	Y
C ALARM HISTORY	N	Y	Y	Y
D MONITOR CERT DATA	N	Y	Y	Y
I MAINTENANCE DATA DIRECTORY				
14 LORAN FAULT ISOLATE RESULTS	N	Y	Y	Y
15 LORAN MON TEST RESULTS	N	Y	Y	Y
16 LORAN 10 MINUTE DATA	N	Y	Y	Y
17 LORAN 4 HOUR DATA	N	Y	Y	Y
18 LORAN BLINK DATA	N	Y	Y	Y
19 LORAN 1 SECOND ALARM DATA	N	Y	Y	Y
20 LORAN 1 MINUTE ALARM DATA	N	Y	Y	Y
J PARAMETER SETUP DIRECTORY				
1 OPERATING PARAMETERS	N	D	D	D,C
2 MONITOR ALARM LIMITS	N	D	D	D,C
5 CERT GEN SETUP	N	D	D,C	D,C
9 LORAN MON TEST GEN SETUP	N	D	D	D,C
10 FUTURE TD CORRECTION VALUES	N	D	D	D,C
11 SET TIME AND DATE	N	Y	Y	Y
12 CLEAR ARCHIVES & INSTALL DEFAULTS	* N	N	N	Y
K COMMANDS RUN TESTS				
1 ABORT TEST	N	N	N	Y
2 CERT TEST	N	N	N	Y
19 TEST LORAN MON	N	N	N	Y
L COMMANDS MAINTENANCE				
1 RECYCLE	* N	Y	Y	Y
2 RESET	N	Y	Y	Y
S SECURITY DIRECTORY	*			
1 LOGON PASSWORD LEVEL	* Y	Y	Y	Y
2 LOGON LOCKOUT LEVEL	* Y	Y	Y	Y
3 LOGON SAFEGUARD LEVEL	* Y	Y	Y	Y
4 CHANGE SECURITY KEYS	* N	N	N	Y
5 LOGOFF MONITOR	* N	Y	Y	Y
6 RETURN TO LORAN DIRECTORY	* N	Y	Y	Y

LEGEND:

N - NO ACCESS SHOULD BE ALLOWED
Y - ACCESS SHOULD BE ALLOWED
D - DISPLAY OF PARAMETER VALUES
C - SHOULD BE ABLE TO CHANGE PARAMETER VALUES
* - COMMANDS AVAILABLE FROM ONLY LORMON IOT PORT

4.14 TEST 14. MULTI-USER COMPATIBILITY (3.2.3.4.2).

The intent of this section was to address the effects of different people using the VOR RMMS network. The following questions were addressed.

1. How does the system function with one person on the IOT and another on the dial-up modem? Who has control of the equipment? Can someone at the FCPU deny access to someone at the RMC-F?

2. What happens if a person does not log off at the FCPU, can someone at the RMC-F obtain access?

Question 1 was tested with the following procedure. The operator was properly logged on at the point described in the left column of the following data. Log-on was then attempted at the test point identified in the top row of the same table. The results of each test were recorded.

Logged on at:		Point Tested						
		LORMON	FCPU			RMC-F		
		IOT	IOT	TTY	MODEM	IOT	TTY	MODEM
LORMON	IOT		*	*	*	*	*	*
FCPU	IOT	*		*	*	*	*	*
	TTY	*	*		*	*	*	*
	MODEM	*	*	*		*	*	*
RMC-F	IOT	*	*	*	*		*	*
	TTY	*	*	*	*	*		*
	MODEM	*	*	*	*	*	*	

Question 2 was tested by being properly logged on at a selected point and then waiting up to 30 minutes to determine if the user would be automatically logged off due to inactivity. The points tested were LORMON IOT, FCPU (TTY/PRINTER) and RMC-F (TTY/PRINTER and dial-up modem ports). The results of each test were recorded.

4.15 TEST 15. EEM INSTALLATION.

Follow the instructions provided in the draft EEM. Record any problems identified during the installation.

5. TEST RESULTS.

This section reports the results of the 14 different types of testing which were conducted on the VOR RMMS network. Each test result is broken down into the following line items:

Logged on at	:	This shows the RMMS point of entry where the operator performed the test.
Executed	:	Describes the command issued and equipment tested.
Requirement	:	Shows the NAS-SS-1000 requirement that the modified RMMS should meet.
Response Times	:	Lists the individual test response times of the equipment being tested.
Avg. Response Time	:	The average response time of the individual tests.

Not specifically identified in the test plan but included in this section are comments about the preproduction installation kit. Prior to integration testing, the FAA Technical Center was tasked with evaluation of the LORMON FCPU port. The results of those bench tests are also included in this section.

The number in parenthesis at the end of the test title identifies the paragraph number from the Integration Test Plan that identifies the test procedure.

5.1 TEST 1. EQUIPMENT SHUTDOWN/TIME TO REPORT STATUS (3.2.3.1.3.1).

Logged on at	:	RMC-F IOT port
Executed	:	"M2" command to SHUTDOWN VOR and TACAN
Requirement	:	Alarm or alert response within 2 minutes
Response Times	:	15,16,19,20,14,16,18,19,16,17 seconds
Avg. Response Time	:	17 seconds

5.2 TEST 2. TIME TO REPORT LORMON OPERATIONAL STATUS TO CONTROL POINT (3.2.3.1.3.3).

Logged on at	:	RMC-F IOT port WITH NO transfer of Loran data through the RMC-F dial-up port.
Execute	:	"J2", LORMON offset = .25 nautical mile (nmi) (Force LORMON position alarm)
Requirement	:	Alarm response within 10 seconds
Response Times	:	12, 5, 11, 10, 7 seconds
Avg. Response Time	:	9 seconds

The same test was conducted as above, this time with Loran archive data being downloaded to the RMC-F dial-up port while time measurements were being taken.

Logged on at	:	RMC-F IOT port WITH transfer of Loran data through the RMC-F dial-up port.
Execute	:	"J2", LORMON offset = .25 nmi (Force LORMON position alarm)
Requirement	:	Alarm response within 10 seconds
Response Times	:	8, 9, 8, 9, 8 seconds
Avg. Response Time	:	8.4 seconds

This test was run while Loran archive data was being sent to the dial-up port of the RMC-F. The average response time of reporting an alarm to the RMC-F IOT display was 8.4 seconds. The same exact test showed that the system was "aware" of the alarm condition much quicker than was reported to the IOT. The simultaneous reporting of the alarm condition to the TTY printer averaged 1.8 seconds from the time in which the alarm condition was invoked.

5.3 TEST 3. TIME TO DETECT AND PRESENT: ALARMS AND STATE CHANGES (3.2.3.1.4.2).

Logged on at : RMC-F IOT port WITH NO transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Transmit a state change within 10 seconds

Response Times :

	Command	Time (Seconds)	Avg.
"L;7T"	Change TACAN active monitor	3,5,7,3,4,6,3,6,6,8	5.1
VOR panel switch	Change VOR state: "Normal" to "By-Pass"	8,8,7,8,7,7,7,11,4,7	7.4
"J;2L"	LORMON offset	12, 5, 11, 10, 7	9.0

Logged on at : RMC-F IOT port WITH transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Transmit a state change within 10 seconds

Response Times :

	Command	Times (Seconds)	Avg.
"L;7T"	Change TACAN active monitor	7,4,10,8,7,6,3,7,3,5	6.0
VOR panel switch	Change VOR state: "Normal" to "By-Pass"	6,8,16,7,14,10,10,12,7,3	9.3
"J;2L"	LORMON offset	8, 9, 8, 9, 8	8.4

5.4 TEST 4. CONTROL COMMAND EXECUTION TIME (3.2.3.1.4.3).

Logged on at : RMC-F IOT port WITH NO transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Execute control commands within average of 5 seconds.

Response Times :

	Command	Times (Seconds)	Avg.
"L;1T"	RESET TACAN	4,3,3,3,3,3,3,4,5,6	3.7
"L;2V" & "L;3V"	SHUTDOWN VOR RESTART VOR	4,7,5,6,5,5,4,4,4,6	5.0
"L;1L"	LORMON RESET	4,2,3,3,3,5,4,2,3,2	3.1

Logged on at : RMC-F IOT port WITH transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Execute control commands within average of 5 seconds.

Response Times :

	Command	Times (Seconds)	Avg.
"L;1T"	RESET TACAN	6,4,6,7,2,3,7,4,3,7	4.9
"L;2V" & "L;3V"	SHUTDOWN VOR RESTART VOR	4,7,6,7,9,4,7,5,5,6	6.0
"L;1L"	LORMON RESET	3,3,4,3,3,4,3,3,4,4	3.4

5.5 TEST 5. PRESENTATION OF REQUESTED INFORMATION (3.2.3.1.4.4).

Logged on at : RMC-F IOT port WITH NO transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Present data within 2 minutes (maximum 10 minutes)

Response Times :

Command		Times (Seconds)
"DV1"	VOR CERT DATA MON1	7, 8, 8, 9
"DV2"	VOR CERT DATA MON2	8, 7
"EV"	VOR TRANS CERT DATA	9, 8
"I;5"	VOR DIAGNOSTICS	19, 19
"DT1"	TACAN CERT DATA MON1	15, 15, 16
"DT2"	TACAN CERT DATA MON2	15, 16
"ET"	TACAN TRANS CERT DATA	10, 10, 10
"DL"	LORAN CERT DATA	10, 9, 8
Average Response Time :		11.2 seconds

Logged on at : RMC-F IOT port WITH transfer of Loran data through the RMC-F dial-up port.

Execute : See data below

Requirement : Present data within 2 minutes (maximum 10 minutes)

Response Times :

Command		Times (Seconds)
"DV1"	VOR CERT DATA MON1	9, 7, 8, 7
"DV2"	VOR CERT DATA MON2	8, 8
"EV"	VOR TRANS CERT DATA	
"I;5"	VOR DIAGNOSTICS	23, 20
"DT1"	TACAN CERT DATA MON1	23, 20
"DT2"	TACAN CERT DATA MON2	
"ET"	TACAN TRANS CERT DATA	12, 11
"DL"	LORAN CERT DATA	8, 8
Average Response Time :		12.3 seconds

The above times excluded the time to actually conduct the CERT TEST. The following times were required to complete a CERT TEST without a Loran archive download in the background: 4 minutes 38 seconds (VOR), 3 minutes 52 seconds (TACAN), and 7 minutes 35 seconds (LORMON). With a Loran archive download to the RMC-F dial-up port, the times for a CERT TEST were: 5 minutes 40 seconds (VOR) and 3 minutes 58 seconds (TACAN). It was not possible to conduct a Loran CERT TEST during a Loran archive download. All times were measured between executing the K;2 command and when the system reported the test complete on the status line of the RMC-F IOT.

5.6 TEST 6. ACKNOWLEDGEMENT OF TEST COMMAND (3.2.3.1.4.5).

Logged on at : RMC-F IOT port WITH NO transfer of Loran data through the RMC-F dial-up port.

Execute : See tables 5.6-1 and 5.6-2 below

Requirement : Acknowledge command within an average time of 15 seconds (75 seconds maximum).

TABLE 5.6-1. TEST COMMAND ACKNOWLEDGEMENT USING G SCREEN
(With No Transfer Of Loran Data)

	Command	Times (Seconds)	Avg.
"K;2V;G"	VOR CERT TEST	11, 10, 11, 11, 11	10.8
"K;8;G"	GROUND CHECK VOR	10, 11, 12, 11, 11	11.0
"K;2T;G"	TACAN CERT TEST	11, 12, 10, 11, 12	11.2
"K;15;G"	TRANS TEST TAC/DME	11, 11, 10, 10, 10	10.4
"K;2L;G"	LORAN CERT TEST	12, 11, 11, 10, 11	11.0
"K;19;G"	TEST LORAN MONITOR	11, 11, 12, 12, 12	11.6
Average Response Time : 11.0 seconds			

TABLE 5.6-2. TEST COMMAND ACKNOWLEDGEMENT USING STATUS LINE ABORT MESSAGE
(With No Transfer Of Loran Data)

	Command	Times (Seconds)	Avg.
"K;1V"	ABORT VOR TEST	15, 14, 13, 14, 14	14.0
"K;1V"	ABORT GRND CHECK VOR	14, 14, 14, 15, 14	14.2
"K;1T"	ABORT TACAN TEST	14, 15, 14, 15, 15	14.6
"K;1T"	ABORT TRANS TEST	8, 9, 13, 11, 16	11.4
"K;1L"	ABORT LORAN TEST	14, 25, 26, 27, 21	22.6
"K;1L"	ABORT TEST LOR MON	20, 25, 24, 20, 20	21.8
Average Response Time : 16.4 seconds			

Logged on at	:	RMC-F IOT port WITH transfer of Loran data through the RMC-F dial-up port.
Execute	:	See tables 5.6-3 and 5.6-4 below
Requirement	:	Acknowledge command within an average time of 15 seconds (75 seconds maximum).

TABLE 5.6-3. TEST COMMAND ACKNOWLEDGEMENT USING G SCREEN (With Transfer Of Loran Data)

	Command	Times (Seconds)	Avg.
"K;2V;G"	VOR CERT TEST	17, 13, 14, 13, 21	15.6
"K;8;G"	GROUND CHECK VOR	22, 22, 20, 22, 19	21.0
"K;2T;G"	TACAN CERT TEST	20, 20, 21, 20, 20	20.2
"K;15;G"	TRANS TEST TAC/DME	21, 17, 12, 14, 16	16.0
"K;2L;G"	LORAN CERT TEST	(NOT AVAILABLE WITH DOWNLOAD	
"K;19;G"	TEST LORAN MONITOR	OF LORAN ARCHIVE DATA.)	
Average Response Time : 18.2 seconds			

TABLE 5.6-4. TEST COMMAND *ACKNOWLEDGEMENT USING STATUS* LINE ABORT MESSAGE (With Transfer Of Loran Data)

	Command	Times (Seconds)	Avg.
"K;1V"	ABORT VOR TEST	21, 20, 14, 18, 18	18.2
"K;1V"	ABORT GRND CHECK VOR	21, 17, 15, 15, 15	16.6
"K;1T"	ABORT TACAN TEST	17, 17, 17, 17, 17	17.0
Average Response Time : 17.3 seconds			

The specialist receives acknowledgement of a valid test command by viewing the system's status on the G screen. When a test command was issued from the appropriate screen, e.g., K;2V", VOR CERT TEST, the operator then switched to the G screen to view the VOR status. If the CERT TEST command was properly received and executed, the G screen status for the VOR would be displaying "CERT". To speed the display of the G screen, it was chained to the "K;2V" command. Some of the commands caused the IOT to show an inverse video 6 to 13 seconds earlier than for the G screen. If the TTY/PRINTER output was used for timing, the time to response was even shorter.

5.7 TEST 7. GENERAL COMMANDS.

The actual commands and ports tested appear in appendix A. All commands were executed correctly except for the following:

1. Loss of phone line connection with the RMC-F dial-up modem port during a Loran archive download may or may not return the system to the desired system state. In three tests (two with dial-up FCPU, one with dial-up RMC-F), the system recovered to a Normal state when the phone line connection was lost. A fourth test, using the RMC-F dial-up, produced results similar to a previously conducted test which was not well documented. In the fourth test, the VOR RMMS system did not hang when the phone line connection was broken but did report incorrect system state messages on the G screen (both FCPU and RMC-F). The Loran "archive in progress" message was observed set for an 18-hour period following a "loss comm" and did not clear. Archive data could not be accessed during this period from any port. RESETing ("L;1L;G"), the LORMON through the FCPU IOT, cleared the bit on the G screen but archive data still could NOT be retrieved. FCPU RECYCLE ("L;12") had to be performed before Normal system archive operations with the LORMON could be conducted. The command could be issued at the FCPU or RMC-F. Other functions of the LORMON did not seem to be affected. A LORAN MON TEST and ABORT TEST worked correctly, as well as the display of LORAN EXECUTIVE data, before the FCPU was recycled to reinstate the system to Normal. This is an improvement over previous firmware versions which hung the VOR RMMS network.

2. When power to the LORMON is interrupted, date and time must be entered into the LORMON in order for it to start the acquisition process. Date and time may be entered from the LORMON IOT or FCPU port. In order for the LORMON to be self-starting, it was decided that the FCPU should transfer time to the monitor about once a minute. This technique was found to be acceptable in the majority of instances.

If the FCPU loses power, it will not continue to send date and time to the LORMON automatically once power has been restored. The automatic transfer of date and time to the LORMON will not start until the FCPU time has been reset. The FCPU date and time may be reset from the FCPU or the RMC-F. In a typical installation, the RMC-F should automatically download the date and time to reset the values in the FCPU. If the RMC-F has had its power recycled it will not transfer date and time to the FCPU until date and time are reset. It is expected that the RMC-C would also be able to download date and time to the RMC-F's to start the time transfer. Due to the equipment setup, no RMC-C was available to test this theory.

3. It is not possible to obtain Loran archive data selected by date/time and number of records from the dial-up modem port of the RMC-F. It is, however, possible to selectively obtain archive data from the IOT and TTY/PRINTER ports of the RMC-F and the dial-up modem, IOT, and TTY/PRINTER ports of the FCPU. National Field Office Loran Data Systems (NFOLDS) will be using the dial-up modem ports on the RMC-F and FCPU to download selected portions of the Loran archive files.

Does INDEXed download work?	RMC-F	FCPU
Dial-up	NO	YES
TTY	YES	YES
IOT	YES	YES

4. The front panel of the LORMON frequently showed an alarm condition when the RMC-F or FCPU indicated an alarm but not every time. Use of the Technical Center developed FCPU simulator indicated the LORMON routinely issued an Executive Alarm over the FCPU port and did not turn on the LORMON front panel Executive Alarm light.

5. Once a LORMON FAULT ISOLATE command is issued, communications with the FCPU port of the LORMON is not possible for approximately 5 minutes. During this time, a request for LORMON EXECUTIVE DATA at RMC-F IOT port returns the operator back to the VORTAC directory (A screen) withc any explanation. If the request is made from the FCPU, a communications fault message will be displayed before returning back to the VORTAC directory (A screen). At both the FCPU and RMC-F, the G screen does correctly show a NO COMM status for the LORMON during this time.

6. Aborting a LORMON FAULT ISOLATE command from the RMC-F or FCPU causes a message to be displayed on the VOR RMMS that Fault Isolate has been aborted. In fact, the LORMON is still executing a Fault Isolate test. This was verified by observing the LORMON front panel LCD display which had a message stating a Fault Isolate Test was in progress.

7. The LORMON does not support the RECYCLE command on the FCPU port. If a RECYCLE command ("L;4L") is issued from the FCPU, the LORMON is not recycled and no adverse actions are taken by the FCPU. To be consistent with other VOR RMMS commands, the FCPU should issue a "SYNTAX ERROR" as it does when other nonfunctional commands are requested. If, however, the same command is issued from the RMC-F, there is an adverse effect. The user is switched from the VORTAC directory back to the T directory. On a normally operating system, the operator must log off to switch from the VORTAC directory to the T directory. Issuing a LORMON RECYCLE command should not switch the operator to the T screen. Although the user is switched to the RMC-F T screen, the user is not logged off the site's VORTAC directory. Access to that site's VORTAC is still locked out from other users. A user attempting to log onto the same VORTAC from any other port will see a message that someone is already logged onto the facility. Logging back in at the RMC-F port, which issued the LORMON RECYCLE command and then logging off, will leave the subsystem in a healthy state. If this procedure is not followed, the automatic timeout feature will eventually log off the operator and return the site to normal access.

8. Integration testing determined that downloading Loran 4-Hour archive data from the RMC-F dial-up modem port, in general, worked correctly. Once transfer of archive data started, the user was logged off the site's VORTAC directory. Log-off was verified by logging onto the site's VORTAC directory from another port in the VOR RMMS network. Access to the VOR and TACAN commands were not restricted, but access to certain LORMON commands were restricted. In particular, commands such as LORAN MONITOR TEST, LORAN CERT TEST, or LORAN MONITOR FAULT ISOLATION could not be executed. Such commands resulted in a message to the user: "LORAN-C busy - Archive in progress".

9. Issuing LORMON FAULT ISOLATE or ABORT LORMON TEST during the downloading of archive data to the RMC-F dial-up port will terminate the data transfer. FAULT ISOLATE must be issued from the LORMON IOT port while the ABORT LORMON TEST command can be issued from any port in the VOR RMMS network (except the port which requested the archive data). Except for terminating the data transfer, the VOR RMMS is in a normal state.

10. Issuing a LORMON BY-PASS command from the FCPU port, during the transfer of archive data to the RMC-F dial-up port, causes the LORMON system state to change. System state on the FCPU system state screen (G) changes the Executive Status from "Archive in Progress" to "Idle". The transfer of Loran archive data to the RMC-F dial-up port however continues. If a request for Loran archive data is attempted from the FCPU IOT, a "LORAN-C busy - Archive in progress" message is displayed. Even though the G screen shows "Idle" for LORMON Executive Status, the archive continues on the RMC-F dial-up port.

11. Placing the G System State screen in automatic update causes the screen to contain erroneous characters when executed at the FCPU IOT. This is a random problem and is difficult to duplicate. Recycling power to the FCPU clears the problem. Occasionally, extra characters also appear on other screens. To facilitate testing, a single IOT was used to access both the FCPU IOT port and the RMC-F IOT port through a mechanical switch box. Changing the cabling so that the FCPU IOT port was directly linked to the IOT seems to reduce the number of occurrences of random extra characters.

12. The RMC-F J screen lists command 9 as LORAN MONITOR CERT SETUP, but the title viewed from the J9 screen is LORAN MON TEST SETUP.

13. The following screens are confusing: L (2, 3, 4, 7, 8, 9, 10), K (3, 4, 6), and J (1, 2, 3). The confusion involves the LORMON. The directions which appear on the screen indicate Loran may have two monitors when only one will exist. In addition, several of these commands indicate Loran is a valid input when Loran is not supported.

14. The LORMON does not:

a. provide an alarm when the electrical power or Heat Ventilation Air Conditioning (HVAC) monitored parameters are out of tolerance at unmanned facilities.

b. provide for the monitoring of electrical power and HVAC systems in unmanned subsystem facilities.

c. provide for the monitoring of smoke, fire, physical intrusion, or any other site hazard in unmanned subsystem facilities.

d. provide for the control of the electrical power and HVAC systems in unmanned facilities.

15. The LORMON is unable to be turned on or off through the VOR RMMS network.

16. The LORMON does not include the new midcontinent chains or the additional station on the Alaskan chain.

17. References to the Loran stations are not according to United States Coast Guard (USCG) nomenclature. This includes references on the VOR RMMS network and on the LORMON IOT and front panel.

18. The M screen of the FCPU lists an option 11 with some garbled title. The M screen should not have an option 11.

19. The I15 LORAN MON TEST (results) parameters are equivalent to the VOR DV1 screen (cert results). DL screen LORAN CERT TEST (results) parameters are equivalent to VOR I2 (MON TEST) parameters. This means that the LORAN CERT TEST and the LORAN MON TEST are not consistent with other FAA CERT and MON TESTs.

20. Executing a VOR command to copy monitor parameters from 1 to 2 or 2 to 1 ("L;9VA" or "L;9VB") occasionally does not work. The parameters are not copied and a message "TEST GEN SETUP COMPLETE" is displayed. An FCPU RECYCLE command clears the condition and then "L;9VA" or "L;9VB" will function correctly.

21. Chaining of the J1 LORMON operating parameters is not possible from the RMC-F. Once the first operating parameter is parsed a "comm fault" will result which terminates further processing of the command. All other J screens will allow chaining of parameters. Chaining of J1 LORMON operating parameters does work properly from the FCPU.

22. Changing the controlling VOR monitor does not cause a system state message to be printed on the TTY and the IOT status header does not show an inverse video "V". This does happen when changing the controlling monitor on the TACAN.

23. When at the RMC-F, issuing a command with an incorrect time format can hang the RMC-F port where the command was issued. The system is able to detect when a number is too large for a field and return a prompt. If the operator should forget to include the seconds, (i.e., 93/01/03 17:32:) the port of entry will hang. The port will not become active until the power to the RMC-F is turned off and back on.

5.8 TEST 8. SUBSYSTEM STATUS REPORTS (3.2.3.2.3).

When the first VOR or TACAN monitor was forced out of tolerance, the TTY/PRINTER reported single monitor systems. The "M" on the TTY/PRINTER was replaced with an asterisk (*) while the "M" on the FCPU IOT status line started to flash inverse video. The RMC-F IOT status line does not contain the maintenance "M". Both conditions indicated a maintenance alert. The Maintenance Alert (H) screen showed the appropriate system was now monitored by a single equipment. Forcing the second monitor out of tolerance caused an alarm. The alarm was reported by changing the appropriate system letter on the IOT to inverse video while an asterisk (*) replaced the letter on the TTY/PRINTER. When the system monitors were returned to in tolerance values, the asterisk(*) was replaced by the appropriate letter on the TTY/PRINTER and the letter was returned to Normal video on the IOT screen.

When the LORMON was forced into an alarm condition, the "L" on the IOT status line was changed to inverse video and the "L" on the TTY/PRINTER status line was changed to an asterisk(*), both indicating an alarm condition. LORMON parameter changes do not get printed on the TTY/PRINTER. It was not possible to create an alert for the Loran.

5.9 TEST 9. LOCAL DATA FILE (3.2.3.2.4).

The B screen was used to obtain Executive data from the VOR, TACAN, and LORMON. In each case, data pertaining to the current subsystem status and performance was obtained. In the case of the VOR and TACAN, the data was formatted as before the LORMON modification. The only exception was the addition of the LORMON information to the B screen. The G screen was used to obtain System State. The display was formatted the same as before the LORMON modification except for the addition of the Loran information. The H screen was not modified by the LORMON modification.

5.10 TEST 10. FAIL SAFE DESIGN (3.2.3.3.1.6).

Turning off the LORMON caused the "L" on the FCPU IOT to be displayed as flashing and in inverse video. This indicated the communications between the FCPU and LORMON were lost. This action did not cause the communications with the VOR or TACAN to be affected. Turning the LORMON power back on corrected the loss of communications signal and indicated a LORMON out of tolerance condition until the monitor properly reacquired the Loran signals.

5.11 TEST 11. LORAN MONITORED PARAMETERS (3.2.3.3.2.3).

The resolution of all output devices displaying LORMON signal-to-noise (S/N) and time difference (TD) parameters were consistent. S/N had a 1-dB resolution and TD had a .01- microsecond (μs) resolution. The B, I16, I17, I19, and I20 screens were used to test correct display resolution. The following data shows the output display device which was used to validate correct S/N and TD resolution.

	LORMON	FCPU	RMC-F
IOT	X	X	X
TTY/PRINTER		X	X
Dial-Up Modem		X	X

Previous testing of only the LORMON showed that the monitor could not detect a loss of signal under certain conditions. When the SNR is approximately 0 dB (as reported by the LORMON) and the Loran transmitter is turned off, the LORMON is unable to detect the loss of signal. The monitor also incorrectly reported blink when a Loran station went off-air.

5.12 TEST 12. POWER OUTAGE (3.2.3.3.2.4).

The LORMON did not continue to operate when the power plug was removed from the unit. The loss of LORMON front panel information was almost immediately after the power was removed. No communications were possible with the monitor during this time. Once power was restored, the monitor was able to restart. The batteries in the LORMON were found to be totally discharged and no replacements were available. LORMON FAULT ISOLATE was unable to detect the dead batteries. The voltage and current used to charge the batteries may not be conducive to long battery life.

5.13 TEST 13. LOG-ON/SECURITY (3.2.3.4.1).

The VOR, TACAN, and LORMON responses to commands at each level of security were tested. The VOR RMMS testing was accomplished at the RMC-F IOT. The results of the test are presented in table 5.13-1.

Table 5.13-2 shows the results of testing various LORMON commands with respect to the three levels of security. The system responded as expected except for the following items. The test plan indicated that an operator logged on at the RMC-F IOT with lockout security should be able to change parameters on the CERT GEN SETUP screen ("J;5") and not be able to execute a CERT TEST ("K;2"). The system responded with opposite results as shown in table 5.13-1. The same results were obtained if the commands were executed on the LORMON IOT. The test plan also indicated that an operator logged on with lockout security should not be able to perform an ABORT Test ("K;1"), CERT TEST ("K;2") or TEST LORAN MON ("K;19"). These commands were granted as shown in table 5.13-2.

TABLE 5.13-1. VOR/TACAN/LORMON COMMANDS - RESULTS
(Tests performed at RMC-F IOT)

Log-on Level	Equipment Selected	Test Command	System Response	Test Command	System Response
1	VOR	B	Y	Change J1	N
2		J;5V	R	K;2V	Y
3		B	Y	*	
1	TACAN	B	Y	Change J1	N
2		J;5T	R	K;2T	Y
3		B	Y	*	
1	LORMON	B	Y	Change J1	N
2		J;5L	R	K;2L	Y
3		B	Y	*	

LEGEND

- * unlimited access, no commands denied
- 1 Password level security
- 2 Lockout level security
- 3 Safeguard level security
- Y Yes, system responded to command
- N No, system did not respond to command
- R System responded to read only requests

TABLE 5.13-2. LORMON SECURITY TEST - Results

	PARAMETER	NONE	SECURITY LEVEL PASS WORD	LOCK OUT	SAFE GUARD
A	LORAN DIRECTORY	* N	Y	Y	Y
B	MONITOR EXEC DATA	N	Y	Y	Y
C	ALARM HISTORY	N	Y	Y	Y
D	MONITOR CERT DATA	N	Y	Y	Y
I	MAINTENANCE DATA DIRECTORY				
	14 LORAN FAULT ISOLATE RESULTS	N	Y	Y	Y
	15 LORAN MON TEST RESULTS	N	Y	Y	Y
	16 LORAN 10 MINUTE DATA	N	Y	Y	Y
	17 LORAN 4 HOUR DATA	N	Y	Y	Y
	18 LORAN BLINK DATA	N	Y	Y	Y
	19 LORAN 1 SECOND ALARM DATA	N	Y	Y	Y
	20 LORAN 1 MINUTE ALARM DATA	N	Y	Y	Y
J	PARAMETER SETUP DIRECTORY				
	1 OPERATING PARAMETERS	N	D	D	D,C
	2 MONITOR ALARM LIMITS	N	D	D	D,C
	5 CERT GEN SETUP	N	D	D	D,C
	9 LORAN MON TEST GEN SETUP	N	D	D	D,C
	10 FUTURE TD CORRECTION VALUES	N	D	D	D,C
	11 SET TIME AND DATE	N	Y	Y	Y
	12 CLEAR ARCHIVES & INSTALL DEFAULTS	* N	N	N	Y
K	COMMANDS RUN TESTS				
	1 ABORT TEST	N	N	Y	Y
	2 CERT TEST	N	N	Y	Y
	19 TEST LORAN MON	N	N	Y	Y
L	COMMANDS MAINTENANCE				
	1 RECYCLE	* N	Y	Y	Y
	2 RESET	N	Y	Y	Y
S	SECURITY DIRECTORY	*			
	1 LOGON PASSWORD LEVEL	* Y	Y	Y	Y
	2 LOGON LOCKOUT LEVEL	* Y	Y	Y	Y
	3 LOGON SAFEGUARD LEVEL	* Y	Y	Y	Y
	4 CHANGE SECURITY KEYS	* N	N	N	Y
	5 LOGOFF MONITOR	* N	Y	Y	Y
	6 RETURN TO LORAN DIRECTORY	* N	Y	Y	Y

LEGEND:

N - NO ACCESS
Y - ACCESS ALLOWED
D - DISPLAY OF PARAMETER VALUES
C - PARAMETER VALUES MAY BE CHANGED
* - COMMANDS AVAILABLE FROM ONLY LORMON IOT PORT

5.14 TEST 14. MULTI-USER COMPATIBILITY (3.2.3.4.2).

Only one user has exclusive control of a subsystem at a time. Once an operator is validly logged onto a subsystem all other users from other points of entry trying to access that same subsystem are locked out. A message is displayed that the subsystem is in use. On two occasions, when testing the effect of losing the phone line connection at the RMC-F dial-up port, it was possible to be logged onto the same subsystem from the FCPU IOT and RMC-F dial-up ports at the same time.

The results of the following tests were with the RMMS system in a normal operating state. While properly logged on at the point described in the left column of the following data, the operator tried to log on at the test point identified in the header of the data. Access results of each test are recorded in the following data:

Logged into VORTAC Directory from:		Attempted 2nd Access Point:						
		LORMON	FCPU			RMC-F		
		IOT	IOT	TTY	MODEM	IOT	TTY	MODEM
FCPU	IOT	N		D	D	D	D	D
	TTY	N	D		D	D	D	D
	MODEM	N	D	D		D	D	D
RMC-F	IOT	N	D	D	D		D	D
	TTY	N	D	D	D	D		D
	MODEM	N	D	D	D	D	D	

N - NO ACCESS TO VORTAC DIRECTORY FROM THIS PORT
D - DENIED ACCESS TO THE VORTAC DIR

If the logged-on user requests a Loran archive data file, the user is automatically logged off of the subsystem once the data starts to be displayed. This makes the site available for access from another point of entry.

Automatic log-off was also tested. Automatic log-off at the RMC-F IOT port occurred 21 minutes, 12 seconds after lack of user activity. Lack of activity at the FCPU IOT caused automatic log-off after 20 minutes, 9 seconds. When the RMC-F modem port was idle for 5 minutes, 28 seconds, the operator was automatically logged off the system.

5.15 TEST 15. INSTALLATION PROBLEMS.

The following problems are related to the preproduction hardware kit installed at the Technical Center as part of the Integration test:

1. Only one of the four split washers (926001-0078) was included in the kit.

2. The VORTAC enhancement wiring harness (932405-001) which runs from the new terminal bracket to the VORTAC enhancement circuit card has the following problems:

a. The cable is very stiff due to the thick spiral wrap used in the manufacture of the harness. The stiff wiring harness, combined with the poor cable strain reliefs, may result in broken wires. The strain reliefs do not adequately hold the cable harness. All the weight of the harness, and the pressure due to the stiff harness, falls on the internal wires and not the harness itself. The internal wires in the harness appear to be only about 20-gauge wire. Wire gauge seems sufficient to meet the electrical requirement, but not the mechanical requirement. Removal of many of the circuit card assemblies in the FCPU chassis will require moving this harness, a further source of broken wires. Better strain reliefs are needed.

b. The labeling of cable assembly W35 (932407-001) and W36 (932408-001) is not adequate. The labeling was accomplished by printing the information on a piece of tubing and then sliding the tubing onto the cable assembly. As the cable is installed, all the labeling slides down or stops at the first obstruction leaving no identification at the end of the cable. The labeling should be anchored to the cable so it does not move.

c. The external strain relief, which is intended to mount on the terminal bracket (093977-001), is too long for the chassis. The mount was intended to reroute cables W35 and W36. When the external strain relief is mounted, the front door of the chassis cannot be closed and the metal strain relief contacts the electrical terminals of a 28 volts direct current (VDC) (50 amp) circuit breaker. The door is held open about three-fourths of an inch. This is an unsafe condition and must be corrected. When the strain relief was installed, cables W35 and W36 had a sharp bending radius. The sharp bending radius was due to the tape used to build up the cable thickness for the RS-232 connector shell. Screws supplied with W35 and W36 cables were too short to go through the connector and external strain relief. Some of the screws for the cable were missing.

5.16 TEST LORMON (VERSION 1.11).

5.16.1 Introduction.

Testing of the LORMON as a stand-alone system was not a part of formal Integration Testing. The LORMON was tested in this configuration in order to determine that the LORMON FCPU port protocol had been implemented according to the ICD. At the time testing started, the VOR RMMS had not been modified to communicate with the LORMON. Testing of the LORMON FCPU port was accomplished using a protocol analyzer and personal computer (PC)-based FCPU simulator. The FCPU port simulator was needed to present correctly formatted information to the LORMON and to decode the LORMON's response. The FCPU simulator was developed by the Technical Center for this project. Potential problems were identified and placed into one of two categories. The categories were FCPU port related or basic LORMON related.

5.16.2 LORMON FCPU Port Results.

The following comments pertain to testing of the LORMON FCPU PORT:

1. Error Detection And Recovery

When the LORMON detects a bad message received through the FCPU port, it should transmit a "BREAK" back out the FCPU port. The LORMON should respond to two more bad messages with a "BREAK". At this point, the LORMON should declare the FCPU port noncommunicating on the next bad message. With the current implementation, if after receiving two bad messages a good message is received, no problem exists. If the third message is also bad, the FCPU port is declared to be noncommunicating. This requires a relink to start communications. Section 7.1 of ICD says the LORMON should respond to at least three bad messages before the LORMON declares the FCPU port to be noncommunicating.

A message sent to the LORMON over the FCPU port tells the LORMON how many words of data will be sent. If the FCPU stops transmission of the message before the full word count is sent or the word count is corrupted, the LORMON waits indefinitely for the rest of the message from the FCPU. The ICD requires an intercharacter gap check, but it does not appear to work.

The LORMON does not implement section 7.2 of the ICD which pertains to handling FCPU detected errors.

2. In accordance with the ICD, all messages sent to the LORMON must have a positive response. For messages that do not require the LORMON to return information, at least a status header should be sent by the LORMON. The LORMON does not provide a positive response to all messages sent to it.

3. The end-of-file (EOF) status can be found in two locations: status header and certain archive data files. The EOF information found in the status header seems to exhibit no recognizable cause and effect. Numerous attempts to identify the mechanism used to set this bit were unsuccessful and, therefore, make this bit useless. The EOF information found in certain archive data files works correctly. The EOF byte is paired with the number of records (NREC) parameter byte and correctly indicates when the current data transfer to the FCPU is the last record.

4. LORMON does not properly set the executive alarm and monitor by-pass bits. During periods of acquisition, CERT TEST, and MONITOR TEST, the Executive Alarm Bit is not set. During FAULT ISOLATE, communications with the FCPU and IOT ports are terminated, therefore, no status is available. The monitor by-pass bit gets set if CERT TEST is entered automatically from Fault Isolate but does not get set if entered directly.

5. The LORMON busy bit is not being set as expected. When the LORMON receives a command or file transfer which causes the monitor to be busy, the busy bit should be set and remain set until the monitor has completed processing the request. As currently implemented, the busy bit does not always get set under these conditions. Obtaining the status of the busy bit with a status only request or as part of another message produces different status.

5.16.3 Basic LORMON.

The following comments pertain to the basic LORMON:

1. At present, information written to the IOT port of the LORMON is not formatted consistently, in particular, the line length and use of carriage return and linefeed vary. Some lines end with only a line feed while other lines end with both a line feed and carriage return command. Lines shorter than 80 characters end with both line feed and a carriage return while lines with 80 characters end with only a line feed. It is expected that the terminal will add the carriage return. When information is presented on the standard FAA IOT, the screen is properly formatted. If a personal computer (PC) is used to display the LORMON information, the information is not properly formatted.

2. The LORMON receiver has automatically tuned notch filters which tune out undesired signals. As currently implemented, information on the setting of the notch filters is not available to the operator.

3. The receiver status information appearing on the front panel of the monitor is not available on the FCPU port. A person operating the monitor from a remote location has no way of knowing when the receiver is in acquisition or Normal track. The operator will only know if the LORMON is in Executive Alarm.

Detailed Loran receiver status information is available from the receiver, but is not available through the LORMON. The receiver status information includes the various tracking modes for each channel of the receiver. This information is not available from the LORMON or VOR RMMS.

4. All Loran archive data files include the Loran-C position as averaged time differences. The Executive Data Screen shows a real-time Loran-C position as an offset in nmi from a reference point. With this implementation, it is not possible for an operator to determine if the present Loran-C position agrees with archived data.

5. As currently implemented, the Loran archive data may not contain valid data versus time of day. The entire archive process starts when the system is turned on or reset. Once the archive process is started, it obtains enough samples to satisfy the particular averaging block (i.e., 10 minutes or 4 hours). If the receiver should go into acquisition for any reason, the LORMON will continue to wait for the right number of samples. This means that a 10-minute average could contain samples collected over a several day period. In addition, the LORMON assumes the data point only took 10 minutes or 4 hours to capture, therefore, the date/time associated with the average will be incorrect for all data points prior to this one.

6. The LORMON currently uses the World Geodetic System of 1972 (WGS-72) for all positioning computations. Airborne Loran receivers are also required to use this datum. The FAA has switched to the North American Datum of 1983 (NAD-83) for all charting.

7. The field has reported that the Loran receiver antenna coupler has a tendency to get filled with water. Once the water enters the coupler, the coupler will fail.

8. The "CLEAR ARCHIVES and INSTALL DEFAULTS" command can only be executed from the LORMON IOT. If the command is accidentally chosen, there is no way to abort the command. Once the command is executed, the archives are cleared and the LORMON uses default operating parameters. Most other commands have subscreens which can be chosen but all have a way to exit without executing the command.

9. The J PARAMETER SETUP DIRECTORY has two titles which differ from the title on the subscreens. The J PARAMETER SETUP DIRECTORY shows the J5 subscreen as "TEST GEN SETUP", but the J5 subscreen is titled "LORAN CERT GEN". A similar condition exists for the J9 subscreen. From the J PARAMETER SETUP DIRECTORY, J9 is titled as "MONITOR CERT SETUP", but the J9 subscreen is titled "LORAN MON TEST SETUP".

10. The monitor By-Pass bit gets set if CERT TEST is entered automatically from Fault Isolate but does not get set if entered directly. The bit does get set properly if the By-Pass enable command is issued.

11. The monitor BY-PASS ENABLE command does set the By-Pass bit but its actual effect on the LORMON is not clear.

6. DATA ANALYSIS.

Integration Testing was based on system requirements found in NAS-SS-1000, the LORMON specification, and knowledge of the entire system. Due to the various equipments which interconnect with or use information supplied by the FCPU card, determining actual requirements for Integration Testing was not straight forward. In many cases, issuing one command resulted in testing several NAS-SS-1000 requirements. The NAS-SS-1000 paragraph number appears to the left of each requirement description. The roman numeral preceding the colon indicates the NAS-SS-1000 volume number. For traceability, the Integration Test Plan paragraph number is included following the keywords Test Plan #. This number shows where the original test procedures were identified. The letters following the keyword Equipment identify which type of equipment is referred to by the requirement. Abbreviations for equipment type are:

V - VOR
T - TACAN
D - DME
L - Loran Monitor
R - The Remote Maintenance Monitoring System.

Testing of the RMC-C and testing the RMC-F with multiple VOR sites was not conducted by the Technical Center. Limited testing was conducted by AOS-240 in Oklahoma City, OK. The testing included an RMC-C and a fully loaded RMC-F using one operational VOR facility and simulating seven other VOR facilities. Several random commands were issued.

6.1 TEST 1. EQUIPMENT SHUTDOWN/TIME TO REPORT STATUS.

NAS Requirements

I:3.2.1.2.5.H	For purposes of national defense, specified navigation facilities shall have the capability to be shut down from a remote location in accordance with Department of Defense (DOD)/FAA agreements.
Test Plan #:	3.2.3.1.3.1
Equipment:	V,D,T

I:3.2.1.2.5.I	Navigation facilities, that shut down, shall provide an alarm or alert to a control point within 2 minutes.
Test Plan #:	3.2.3.1.3.2
Equipment:	V,D,T

Analysis

The VOR and TACAN were able to be shut down from the RMC-F using the "M2" command. The time between issuing the command and seeing an alarm at the RMC-F varied between 14 and 20 seconds for 10 trials. The average of 10 trials was 17 seconds. The modified VOR RMMS network meets the requirements.

6.2 TEST 2. TIME TO REPORT LORMON OPERATIONAL STATUS TO CONTROL POINT.

NAS Requirements

I:3.2.1.2.5.K	Supplemental navigation system monitors shall provide operational status to a control point within 10 seconds.
Test Plan #:	3.2.3.1.3.3
Equipment:	L

Analysis

When no Loran archive data was being downloaded, it took between 5 and 12 seconds for a LORMON alarm message to be received at the RMC-F IOT. The average for the five trials was 9 seconds. The time to provide operational status was measured between the alarm light on the LORMON being illuminated and an inverse L being shown on the RMC-F IOT. Since it is possible that the downloading of Loran archive data could delay the transmission of status, the test was repeated while downloading Loran archive data. The data was sent to the dial-up port of the RMC-F. Under these conditions, it took between 8 and 9 seconds to receive a LORMON alarm at the RMC-F IOT. The average for the five trials was 8.4 seconds. It should be noted that the system knew that the LORMON was in an alarm status much sooner than reported on the RMC-F IOT. This was observed on the TTY/PRINTER. During testing, the TTY/PRINTER was used to record all status reports. Review of these printouts indicated that the system knew the LORMON was in alarm within an average of 2 seconds. The modified VOR RMMS network meets the requirements.

6.3 TEST 3. TIME TO DETECT AND PRESENT: ALARMS AND STATE CHANGES.

NAS Requirements

I:3.2.1.2.9.B	The NAS shall provide the capability to detect and present alarms and state changes from selected subsystems to NAS specialists within an average of 10 seconds and a maximum time (99th percentile) of 60 seconds.
Test Plan #:	3.2.3.1.4.2
Equipment:	V,D,T,L,R

Analysis

As stated earlier, the focus of testing was to show that adding the LORMON to the VOR RMMS did not adversely effect the VOR RMMS. Transferring Loran archive data greatly increases the amount of data being transferred by the VOR RMMS. If the time to detect and present alarms and state changes were affected, it would be expected to occur during the transfer of Loran data. Only selected alarms and state changes were tested for the VOR and TACAN, with and without the transfer of Loran archive data. Test 3 was limited to recording execution times for state changes of the TACAN and VOR. Alarm times were recorded as part of testing conducted for Control Command Execution Times (Test 4). This was done to avoid redundancy.

The TACAN was forced to have a state change by changing the active monitor. With no Loran archive data being transmitted, it took between 3 and 7 seconds for the state change to be observed on the RMC-F IOT. The average for the 10 trails was 5.1 seconds. Under the same conditions, but with Loran archive data being sent to the RMC-F dial-up port, the times were increased. The time to report a state change ranged from 3 to 10 seconds. The average for the 10 trials was 6 seconds. This was an increase of 0.9 seconds from the no archive data condition. When the command was given to change the TACAN active monitor, the RMC-F IOT display would occasionally not show an inverse video T and/or D as expected. The TTY/PRINTER did log the state change during the transition period. The reason may be due to the short duration of the event. In Test 4, the control command TACAN RESET (L;1T), was used to test command execution and also cause a system alarm. The average time for the TACAN to alarm was 3.7 seconds (10 trials) with no transfer of Loran data through the RMC-F dial-up port and 4.9 seconds with a Loran archive transfer going on. The TACAN met this NAS requirement.

The VOR state change was initiated by turning the VOR front panel switch from Normal to By-Pass mode. All the response times were greater than for the TACAN condition. With no Loran archive data being transmitted, the response times ranged from 4 to 11 seconds. The average for the 10 trails was 7.4 seconds. Under the same conditions, but with Loran archive data being transmitted to the RMC-F dial-up port, the response times ranged from 3 to 16 seconds. The average for the 10 trails was 9.3 seconds, an increase of 1.9 seconds. Test 4 used the "L;2V" (SHUTDOWN) and "L;3V" (RESTART) control commands for the VOR. These control commands also caused an alarm condition. The VOR average response times for an alarm (10 trials) were 5.0 and 6.0 seconds, respectively, without and with a Loran archive in process. The VOR met this NAS requirement.

LORMON state changes appearing on the VOR RMMS G System State Screen include by-pass, alarm, and executive status. Executive status includes CERT TEST, MON TEST, FAULT ISOLATE, and Loran ARCHIVE in progress. It is not possible to execute a CERT TEST, MON TEST, or FAULT ISOLATE procedure during the downloading of Loran archive data. Since it was not possible to test the effect of downloading Loran archive data on state change times for CERT TEST, MON TEST, or FAULT ISOLATE, testing was limited to LORMON alarm reporting times. The data collected during TEST 2 was used over again in this section. The LORMON showed an alarm within an average of 9.0 seconds without Loran archive data being downloaded and 8.4 seconds with archive data meeting the NAS requirement. An estimate of state change times can be found from measurements made during the testing of the Acknowledgement of Test Command (Test 6). During this test, commands to execute a LORAN MONITOR TEST and LORAN CERT TEST were issued. It took an average of 11.0 and 11.6 seconds to issue the command and receive a state change message on the G screen. This was without a Loran archive in progress. While the times exceed the NAS requirement for average time by 1.6 seconds, the largest single value was only 12 seconds which is well within the maximum value of 60 seconds. It must be noted that the measurement includes both the time to execute the command and to respond.

TACAN, VOR, and LORMON commands tested in this section met the NAS requirements. The requirements were met regardless of whether or not Loran archive data were being downloaded.

6.4 TEST 4. CONTROL COMMAND EXECUTION TIME.

NAS Requirement

I:3.2.1.2.9.C	The NAS shall provide the capability to execute control commands (that cause a state change) initiated by NAS specialists within an average time of 5 seconds and a maximum time (99th percentile) of 15 seconds.
Test Plan #:	3.2.3.1.4.3
Equipment:	V,D,T,L,R

Analysis

NAS-SS-1000 requires the execution of control commands that cause a state change to occur within an average of 5 seconds and a maximum of 15 seconds. The following Control commands were tested:

TACAN	RESET	"L;1T"
VOR	SHUTDOWN	"L;2V"
	RESTART	"L;3V"
LORMON	LORMON RESET	"L;1L"

Execution of the command was verified by observing the front panel lights on the equipments. The TACAN RESET command caused the green panel light to momentarily turn off. The VOR SHUTDOWN command caused the green panel light to extinguish for the duration of the shutdown. The LORMON RESET command switched off the lights indicating Normal track and the acquisition bulb was switched on.

For the TACAN, the control commands took from 3 to 6 seconds to execute when no Loran archive data was being transferred through the RMC-F dial-up port. The average was 3.7 seconds (10 trials). The same test being run on the TACAN, but with a Loran archive download in progress, resulted in an average execution time of 4.9 seconds. The execution times ranged from 2 through 7 seconds over the 10 trials. The commands tested met the NAS requirement.

With no Loran archive transfer in progress, the VOR SHUTDOWN and RESTART control commands executed within an average of 5.0 seconds (10 trials). Individual test times ranged from 5 to 7 seconds. With a Loran archive download going on, the VOR averaged 6.0 seconds to execute the same control commands. The VOR SHUTDOWN/ RESTART time exceeds the NAS requirement by 1 second while Loran archive data was being downloaded to the RMC-F dial-up port. While the average time exceeded the NAS-SS-1000 requirement, all single data points were well within the maximum time (99th percentile) of 15 seconds. The largest single time to execute a command was 9 seconds. Testing was conducted on only two commands. If other state changes or alarms were tested, it is possible the average would be in tolerance. Transferring Loran archive data increased the average time by only 1 second and single measurement values by 2 seconds. It would seem that these values should have no major effect on the VOR RMMS network or safety.

When logged on at the RMC-F IOT port, without downloading Loran 4-Hour Archive data, the LORMON RESET command required an average of 3.1 seconds to execute (10 trials). The same command executed in an average of 3.4 seconds when LORMON archive data was being downloaded to the RMC-F dial-up port. The commands tested met the NAS requirement.

TACAN and LORMON commands tested in this section met the NAS requirements. The requirements were met regardless of whether or not Loran archive data was being downloaded. The VOR commands met the NAS requirement without the transfer of Loran archive data. The average time to execute the command exceeds the requirement by 1 second when a Loran archive transfer was in progress. While the average time to execute a command did exceed the NAS requirement, it should be considered a noncritical failure.

6.5 TEST 5. PRESENTATION OF REQUESTED INFORMATION.

NAS Requirement

I:3.2.1.2.9.D	The NAS shall provide the capability to develop and present certification, diagnostic test, and unmanned facility data as requested by NAS specialists or determined in adaptation within an average time of 2 minutes and a maximum time (99th percentile) of 10 minutes.
Test Plan #:	3.2.3.1.4.4
Equipment:	V,D,T,L,R

Analysis

This requirement is interpreted to mean that the information from a previously executed command to conduct a certification or diagnostic test must be formatted and presented within the required time. For example, the actual certification or diagnostic test need not be completed within the required time. Without a LORMON archive in progress, times required to complete a CERT TEST were: 4 minutes, 38 seconds (VOR), 3 minutes, 52 seconds (TACAN), and 7 minutes, 35 seconds (LORMON). With a Loran archive in progress to the dial-up port of the RMC-F, times required to complete a CERT TEST were: 5 minutes, 40 seconds (VOR) and 3 minutes, 58 seconds (TACAN). The LORMON CERT TEST command cannot be executed during an archive download. These tests were repeated several times over the course of testing the system and all produced similar times. Since the times to complete a diagnostic test for the VOR and TACAN exceed the average time requirement, without a Loran archive download in progress, it must be assumed that the NAS requirement applies only to the display of the data. The times were measured between executing the "K;2" command and when the G screen reported the test complete.

Twenty-one tests were conducted to measure the time between executing the command and presentation of VOR, TACAN, and LORMON certification and diagnostic data. These tests were run without downloading Loran archive data to the RMC-F dial-up port. The time to format and present the data ranged from 7 to 19 seconds with an average of 11.2 seconds. The same tests were repeated with a Loran archive data transfer in progress. There were 14 trials with times which ranged from 7 to 23 seconds. The average time was 12.3 seconds. These times excluded the time to actually conduct the CERT/DIAGNOSTIC Test. Display of requested information (excluding the actual test) met the NAS average time requirement.

Time to conduct an actual CERT TEST (without display) for the VOR, TACAN, and LORMON clearly exceed the 2-minute average time requirement for presentation of requested information. Conducting the CERT TEST does meet the 10-minute maximum time requirement. If the time to display the information is added to the time to conduct a test, the 10-minute maximum time requirement can still be met.

For analysis purposes, time to complete an actual CERT TEST was measured. A CERT TEST was chosen because it should take longer to complete than a MON TEST. As presently implemented, the LORMON CERT TEST is really equivalent to a typical FAA Monitor Test. The opposite is also true. A LORMON MON TEST is equivalent to a typical FAA CERT TEST. A MON TEST is typically a short test to verify a monitor is functional. Certification Tests are designed to verify that the monitor is able to detect signal conditions which are in or out of tolerance. It takes the LORMON approximately 45 minutes to complete what it calls a Monitor Test. If the NAS requirement includes both the actual testing and the display of the information, the LORMON does not meet the NAS requirement. The modified VOR RMMS meets the NAS-SS-1000 requirements if the requirement is to display only the data and not to collect the data.

6.6 TEST 6. ACKNOWLEDGEMENT OF TEST COMMAND.

NAS Requirement

I:3.2.1.2.9.E	The NAS shall provide an acknowledgement to a specialist of a subsystem's receipt of a valid test command, input by the specialist, within an average time of 15 seconds and a maximum time (99th percentile) of 75 seconds.
Test Plan #:	3.2.3.1.4.5
Equipment:	V,D,T,L,R

Analysis

Test commands are issued and acknowledgements are received from different screens. Acknowledgement of valid test commands can be viewed on the system's status screen (G screen) while test commands are generally issued from the K screen. Some commands are also acknowledged with a message displayed on the status line of the IOT. When a test command was issued from the appropriate screen (i.e. "K;2V", VOR CERT TEST), the operator would then switch to the G screen to view the status. If the VOR CERT TEST command was issued and properly received, the G screen status would show "CERT" for the VOR. The fastest method to issue a command and receive status is by chaining the commands together. At the RMC-F IOT, it takes at least 10 seconds to issue any command and obtain the display of the G screen even when the commands are chained. At the FCPU IOT, the entire process can be executed considerably faster.

For Test 6, all commands were issued from the RMC-F IOT port. This was done to obtain the longest time delay. In the length of time it took the VOR RMMS to issue the command and display the G screen information, the "CERT" Test in progress message would already have been posted. For this reason, it was not possible to measure this parameter accurately. After issuing a test command and recording the time to acknowledge the command, the test was aborted. This method reduced the time to conduct the test and also doubled the number of samples. Acknowledgement for aborting a test was shown on the IOT status line.

The results of testing do not provide a clear answer to substantiate compliance with the NAS requirement. It always took longer to obtain an acknowledgement of test command when downloading Loran archive data to the RMC-F dial-up modem port than without the transfer of archive data. Individual times were increased from 1 to 12 seconds when an archive was in progress. Aborting a Loran MON TEST took from 14 to 27 seconds while aborting a VOR or TACAN MON TEST took 8 to 15 seconds. It was not possible to issue test commands for the LORMON when the transfer of Loran archive data was in progress. If the time to acknowledge all 85 commands are averaged (15 seconds), the NAS requirement of 15 seconds is just met. Average times to acknowledge a specific test command did not always meet the NAS requirement. The largest average time to acknowledge a specific test command was 22 seconds for aborting a LORMON test. The largest single time to acknowledge a test command was 27 seconds. If the mean +3 standard deviations are used to determine the 99th percentile, the NAS requirement of 75 seconds is still met. The 99th percentile value for the 85 points was 30 seconds.

Setting a time requirement for acknowledging a test command can only be to ensure the operator does not have to wait an undetermined length of time to know if the command was accepted. If the requirement was intended to set an upper time limit to wait when conducting automatic testing, the average value will have little significance. The important parameter for automatic testing would be the maximum time to acknowledge a test command not the average time. The modified VOR RMMS clearly meets the NAS requirement for maximum time to acknowledge a test command. Failure to meet the average time requirement should be considered a noncritical failure.

6.7 TEST 7. GENERAL COMMANDS.

NAS Requirements

I:3.2.1.1.5.1.H	Transmission of an alarm/alert to a control point.
Test Plan #:	3.2.3.1.1.1
Equipment:	V,D,T
I:3.2.1.1.5.1.J	Monitoring of supplemental navigation systems.
Test Plan #:	3.2.3.1.1.2
Equipment:	L
I:3.2.1.1.9.1.A	The NAS shall continually monitor subsystem performance to obtain the data needed by specialists for maintenance and operations support.
Test Plan #:	3.2.3.1.2.1
Equipment:	V,D,T,L,R
I:3.2.1.1.9.1.B	The NAS shall provide the status of subsystems to specialists and shall generate an alarm upon the deviation of designated parameters from prescribed limits.
Test Plan #:	3.2.3.1.2.2
Equipment:	V,D,T,L,R
I:3.2.1.1.9.1.C	The NAS shall provide the capability for a specialist on-site or at an off-site location to control selected subsystems for maintenance purposes.
Test Plan #:	3.2.3.1.2.3
Equipment:	V,D,T,L,R
I:3.2.1.1.9.1.D	The NAS shall provide the specialist the capability to identify the line replaceable units causing an equipment failure.
Test Plan #:	3.2.3.1.2.4
Equipment:	V,D,T,L,R

I:3.2.1.1.9.1.E	The NAS shall provide the capability to retain the values of all monitored subsystem data and the preventive and corrective maintenance data input by specialists.
Test Plan #:	3.2.3.1.2.5
Equipment:	R

I:3.2.1.1.9.1.F	The NAS shall provide for the organization and processing of the information necessary for the management of maintenance resources and the preparation of NAS status reports.
Test Plan #:	3.2.3.1.2.6
Equipment:	R

I:3.2.1.1.9.1.G	The NAS shall provide the specialist access to the monitoring, control, and data management capabilities of the NAS as required and as authorized by administrative directives.
Test Plan #:	3.2.3.1.2.7
Equipment:	V,D,T,L,R

I:3.2.1.2.9.A	The NAS shall provide the capability to continually monitor the status, alarms/alerts and performance data of selected subsystems.
Test Plan #:	3.2.3.1.4.1
Equipment:	V,D,T,L,R

I:30.1.1.1	The NAS shall provide for the monitoring of designated subsystems performance parameters.
Test Plan #:	3.2.3.2.1
Equipment:	V,D,T,L,R

I:30.1.1.2	The NAS shall provide subsystem operations status data including configuration and mode of operation.
Test Plan #:	3.2.3.2.2
Equipment:	V,D,T,L,R

I:30.1.1.5	The NAS shall provide subsystem data in response to requests from RMMS subsystems.
Test Plan #:	3.2.3.2.5
Equipment:	V,D,T,L,R

I:30.1.1.7	The NAS shall provide an alarm when smoke, fire, or physical intrusion into a subsystem facility has occurred (Site Specific).
Test Plan #:	
Equipment:	V,D,T,L,R

I:30.1.1.8	The NAS shall provide an alarm when the electrical power or Heat Ventilation Air Conditioning (HVAC) monitored parameters are out of tolerance at unmanned facilities (site specific).
Test Plan #:	3.2.3.2.8
Equipment:	V,D,T,L,R
I:30.1.1.11	The NAS shall provide the capability to set or change ranges for subsystems alarm or alert parameters.
Test Plan #:	3.2.3.2.11
Equipment:	V,D,T,L,R
I:30.1.1.12	The NAS shall provide for the disabling of a subsystem alarm or alert as performance data.
Test Plan #:	3.2.3.2.12
Equipment:	V,D,T,L,R
I:30.1.1.13	The NAS shall report the disabling of a subsystem alarm or alert as performance data.
Test Plan #:	3.2.3.2.13
Equipment:	V,D,T,L.R
I:30.1.1.14	The NAS shall provide subsystem certification data in response to a certification exercise.
Test Plan #:	3.2.3.2.14
Equipment:	V,D,T,L,R
I:30.1.1.15	The NAS shall provide subsystem diagnostic data in response to a diagnostic test request.
Test Plan #:	3.2.3.2.15
Equipment:	V,D,T,L,R
I:30.1.1.16	The NAS shall provide for the monitoring of electrical power and HVAC systems in unmanned subsystem facilities (site specific).
Test Plan #:	3.2.3.2.16
Equipment:	V,D,T,L,R
I:30.1.1.17	The NAS shall provide for the monitoring of smoke, fire, physical intrusion or any other site hazard in unmanned subsystem facilities (site specific).
Test Plan #:	3.2.3.2.17
Equipment:	V,D,T,L,R

I:30.1.1.18	The NAS shall provide for the control to change the current operating mode of a subsystem to any other proper operating mode of a subsystem including on/off.
Test Plan #:	3.2.3.2.18
Equipment:	V,D,T,L,R
I:30.1.1.19	The NAS shall provide the capability to adjust selected subsystem parameters.
Test Plan #:	3.2.3.2.19
Equipment:	V,D,T,L,R
I:30.1.1.20	The NAS shall provide the capability to reset a subsystem.
Test Plan #:	3.2.3.2.20
Equipment:	V,D,T,L,R
I:30.1.1.21	The NAS shall provide for the initiation of subsystem diagnostic tests for the purpose of fault isolation.
Test Plan #:	3.2.3.2.21
Equipment:	V,D,T,L,R
I:30.1.1.22	The NAS shall provide for the initiation of subsystem certification exercises.
Test Plan #:	3.2.3.2.22
Equipment:	V,D,T,L,R
I:30.1.1.23	The NAS shall provide for the control of the electrical power and HVAC systems in unmanned facilities (site specific).
Test Plan #:	3.2.3.2.23
Equipment:	V,D,T,L,R
I:30.1.1.24	The NAS shall provide for the specialist access to the RMMS network through a maintenance data terminal with the proper authorization.
Test Plan #:	3.2.3.2.24
Equipment:	V,D,T,L,R
III:3.2.1.3.8.1.4	Data Retrieval - The Loran-C Aviation Monitor shall transmit stored data upon request.
Test Plan #:	3.2.3.3.1.4
Equipment:	L

III:3.2.1.3.8.1.5	Operational Status - The Loran-C Aviation Monitor shall transmit the operational status of the navigation signals to the air traffic control facilities responsible for flight operation in the area serviced by the Loran-C Aviation Monitor.
Test Plan #:	3.2.3.3.1.5
Equipment:	L

III:3.2.1.3.8.1.8	Maintenance Data - The Loran-C Aviation Monitor shall transmit maintenance as indicated in Table 3.2.1.3.8.3-1 of the NAS System Specification, NAS-SS-1000 volume III.
Test Plan #:	3.2.3.3.1.8
Equipment:	L

III:3.2.1.3.8.1.9	Maintenance Commands - The Loran-C Aviation Monitor shall respond to maintenance commands as indicated in Table 3.2.1.3.8.3-1 of the NAS System Specification, NAS-SS-1000 volume III.
Test Plan #:	3.2.3.3.1.9
Equipment:	L

III:3.2.1.3.8.2.1	Signal Reception - The Loran-C Aviation Monitor shall be capable of receiving all North American, Alaskan, Hawaiian Loran-C transmissions as described by 3.1.2.3.h of the NAS System Specification, NAS-SS-1000 volume III.
Test Plan #:	3.2.3.3.2.1
Equipment:	L

III:3.2.1.3.8.3	The Loran-C Aviation Monitor shall interface functionally and physically as shown in Figure 3.2.1.3.8.3-1 of the NAS System Specification, NAS-SS-1000 volume III.
Test Plan #:	
Equipment:	L,R

Analysis

The requirements identified for this test were met by the modified VOR RMMS network except as noted. A brief description of the problem and an analysis of the problem is presented for each item. If a NAS or LORMON requirement could be identified, it appears in parenthesis after the explanation. The LORMON interface control document (ICD) is numbered FAA ICD98390-8000. Details of the problems can be found in section 5.7 of this report. The problems are:

1. Interruption of the phone connection during the downloading of Loran archive data from the RMC-F dial-up modem port may affect further access to the LORMON. Incorrect LORMON status messages may appear on the G screen of the IOT. Erroneous messages such as "LORAN-C busy, Archive in progress" have been observed on the G screen of the IOT. It is also not possible to retrieve Loran archive data after this event. Resetting the LORMON ("L;1L;G") through the FCPU IOT clears the archive in progress message on the status screen but Loran archive data could not be retrieved. Only executing an FCPU RECYCLE ("L;12") returned the system to normal.

The aforementioned condition makes it impossible for a technician to determine if a Loran archive download is truly being conducted or if the FCPU needs to be recycled due to a lost communications condition on the RMC-F dial-up port. If the FCPU is recycled and there is an archive download in progress, it will be ABORTED midstream. Since NFOLDS will not be part of each region, but a centrally located organization, it is highly possible that Loran archive data could be retrieved at almost anytime. When the phone line is disconnected during the downloading of Loran archive data, it is also possible to be logged onto that particular site's VORTAC directory from both the FCPU IOT and RMC-F dial-up at the same time. These conditions are an improvement over previous versions of software in which the RMC-F and FCPU were effected. The potential for phone line disconnects is escalated by the fact that frequently Loran archive data downloads may require an hour or more for data transfer. This should be considered a critical failure (I:3.2.1.1.9.1.C, I:3.2.1.1.9.1.G, I:30.1.1.26, III:3.2.1.3.8.1.4, III:3.2.1.3.8.3).

2. Loss of power to the LORMON will stop the monitor from reacquiring until date and time are reset. As currently implemented, the LORMON does not go into an executive alarm at power-up. Without an Executive Alarm, the receiver being in acquisition might go unnoticed for a long time. When the LORMON is in acquisition, no Loran archive data is being collected. If the receiver is in acquisition for a long time there might not be enough data to compute a correction value to support the approach. Under normal conditions, the FCPU will update the LORMON date and time periodically. This practice will automatically restart the LORMON. If the FCPU should be recycled without resetting date and time, it will not automatically transmit date and time to the LORMON. Without a date and time update, the LORMON will not be able to collect the necessary data. Time can be set at the FCPU or from the RMC-F. The RMC-F can send time automatically or when requested by an operator. Automatic transfer of time from the RMC-F to the FCPU will only take place if the time in the RMC-F has been reset after a RMC-F power up. Since correct time is the only way for maintenance personnel to correlate data, it is expected that normal operating procedures should handle this situation. If the LORMON RECYCLE command is implemented on the LORMON FCPU port so that the command works correctly on the VOR RMMS network, this could cause a similar problem. Executing the LORMON RECYCLE command from the LORMON IOT requires date and time to be entered before acquisition will start. This is not a NAS integration issue but an operational issue. The operator of the LORMON must be made aware of the requirement to enter date and time.

3. It is not possible to obtain Loran archive data selected by date/time and number of records from the dial-up modem port of the RMC-F. NFOLDS will be using the dial-up modem ports on the RMC-F and FCPU to download selected portions of the Loran archive files. Dumping the entire archive files when only new data is needed will increase the time required to obtain the data. Since NFOLDS will be obtaining data from 196 LORMONs, this could be a significant increase in time needed obtain the data. Testing has shown that Loran archive data is selectable by date/time and number of records from all other points of entry in the VOR RMMS network. Even the port on the LORMON which interfaces to the FCPU works correctly. The problem must, therefore, be in the VOR RMMS network. This should be considered a critical problem as it could effect the operation of NFOLDS (III:3.2.1.3.8.3, LORMON ICD).

4. The LORMON Executive Alarm status can be accessed through the FCPU port of the LORMON, LORMON IOT port, or the LORMON front panel. During testing the LORMON frequently displayed an alarm condition on the front panel which corresponded with an RMC-F or FCPU IOT displayed Loran alarm. There were occasions when the RMC-F or FCPU displayed an alarm but none was apparent from the LORMON front panel. Investigation of the problem has shown that the VOR RMMS correctly displays the Executive Alarm status when the status bit is set. It is the LORMON which does not set the front panel alarm light and status bit (FCPU port of LORMON) consistently. When a technician is able to view both the front panel of the LORMON and obtain status from the FCPU IOT, which alarm is correct? Alarm status must be consistent, therefore, this should be considered a critical failure (III:3.2.1.3.8.3, LORMON Spec).

5. Once a LORAN MONITOR FAULT ISOLATION command is issued, communications with the FCPU port of the LORMON is not possible for approximately 5 minutes. Since no communications is possible, the operator would be unable to determine the state of the Loran Monitor or abort the command. This should be considered a critical failure. (I:3.2.1.1.9.1.A, I:3.2.1.2.9.A - Loss of communications with the VOR RMMS or attached equipments for any reason violates other NAS requirements but these are the principle requirements.)

6. Issuing an ABORT LORAN MONITOR FAULT ISOLATE command from the VOR RMMS network causes an incorrect system state to be displayed. The system state shows that the FAULT ISOLATE command has been terminated when in fact FAULT ISOLATE continues. Incorrect system state messages makes it impossible to know how the LORMON is functioning. This should be considered a critical failure (I:30.1.1.2).

7. The LORMON does not support the RECYCLE command on the FCPU port of the monitor. Testing has shown that the VOR RMMS does not handle the LORMON RECYCLE command consistently. If a LORMON RECYCLE command is issued from the FCPU, the command is ignored and there are no adverse effects. To be consistent with other VOR RMMS commands, the FCPU should issue a "SYNTAX ERROR" as it does when other nonfunctional commands are requested. If the LORMON RECYCLE command is issued from the RMC-F, the response is very different. The operator is switched from the VORTAC directory to the RMC-F directory (T screen) and access to the site's VORTAC directory is locked out from all ports of entry. This sequence is very similar to the normal VORTAC log-off procedure when at the RMC-F, but access to the VORTAC directory should not be restricted. There are two ways in which access to the VORTAC can be regained. Logging back in at the RMC-F port which issued the LORMON RECYCLE command and then logging off will leave the system in a healthy state. If this procedure is not followed, the automatic timeout feature will eventually log off the operator and return the system to normal.

When a LORMON RECYCLE command is issued, both the FCPU and RMC-F should be consistent in the way that it is handled. The RMC-F response to the command effects further access to the subsystem from all other ports of entry. Other users may be locked out for a period of up to 25 minutes (the length of the automatic timeout feature). Since the command is not supported by version 1.11 of the LORMON, the equipment's response to the operator should be "SYNTAX ERROR". This should be considered a critical failure (I:3.2.1.1.9.1.C).

8. When downloading Loran archive data, access to the LORMON is limited. In particular, commands such as LORAN MONITOR TEST, LORAN CERT TEST, or LORAN MONITOR FAULT ISOLATION could not be executed. This would limit the ability of Airways Facilities personnel to perform LORMON testing during the downloading of Loran archive data. The inability to initiate subsystem diagnostic tests or certification exercises during this time period could be considered a NAS violation. No specification was found to state that the operations had to be simultaneous. The operator downloading Loran archive data has the ability to terminate the data transfer if another user requires access. This should be considered a noncritical issue (I:30.1.1.21, I:30.1.1.22).

9. When downloading Loran archive data to the RMC-F dial-up port, a user at another VOR RMMS port can terminate the transfer. Archive data can be terminated by issuing ABORT MON TEST on the VOR RMMS or FAULT ISOLATE on the LORMON IOT. The ability to terminate the downloading of Loran archive data by a user at another port could be a nuisance but should not be a major problem. This should be considered a noncritical issue.

10. Issuing a LORMON BY-PASS command, from the FCPU IOT port during the downloading of Loran archive data, produces an incorrect LORMON system state. The System State screen shows the LORMON as "Idle" when in fact an archive continues to be transferred to the RMC-F dial-up port. Incorrect system state messages make it impossible for an operator to know the state of the LORMON. This should be considered a critical failure (I:30.1.1.2).

11. Erroneous characters have appeared on the FCPU IOT screen. On occasion extra characters have appeared on other screens. It was necessary to recycle power to the FCPU to clear the condition on at least one occasion. Only one IOT was used during testing. In order to view data from the RMC-F IOT port and FCPU IOT, a mechanical switch was used to select the desired port for the IOT. This eliminated the need to constantly change the cabling. During periods when only one port was selected and after changing the location of a test cable, the number of erroneous characters was greatly reduced. This should be considered a problem related to the test setup and not a VOR RMMS or LORMON problem.

12. The RMC-F IOT port J screen lists command 9 as LORAN MONITOR CERT SETUP when viewed from the J screen and as a LORAN MONITOR TEST when viewed from the J9 screen. A MONITOR TEST and a CERT TEST are two different tests. To avoid confusion the screens should be consistent. This should be considered a noncritical issue.

13. The following screens are confusing: L (2, 3, 4, 7, 8, 9, 10), K (3, 4, 6), and J(1, 2, 3). The confusion involves the LORMON. The directions which appear on the screen indicate Loran may have two monitors when only one exists. In addition, several of these commands indicate Loran is a valid input when Loran is not supported. To avoid confusion, the directions on the screen should be improved, or training should address this point. This should be considered a noncritical issue.

14. The LORMON does not:

a. provide an alarm when the electrical power or HVAC-monitored parameters are out of tolerance at unmanned facilities.

b. provide for the monitoring of electrical power and HVAC systems in unmanned subsystem facilities.

c. provide for the monitoring of smoke, fire, physical intrusion, or any other site hazard in unmanned subsystem facilities.

d. provide for the control of the electrical power and HVAC systems in unmanned facilities.

In the October 1989, update to the NAS-SS-1000, the requirement for the LORMON to monitor smoke, fire, or physical intrusion (I:30.1.1.16) and monitor electrical power and HVAC (I:30.1.1.17) have been removed. This update does not, however, remove the requirement to control the electrical power and HVAC systems (I:30.1.1.23) or provide an alarm when smoke, fire, or physical intrusion has occurred (I:30.1.1.7). The LORMON is planned to be located at a VOR site. Each VOR site already monitors these parameters. The lack of these functions should, therefore, have no operational significance. These requirements were tested during Field Operational Verification Test (FOVT). It was determined that the VOR RMMS network was able to meet these requirements. This should be considered a noncritical failure (I:30.1.1.7, I:30.1.1.8, I:30.1.1.23).

15. The LORMON is unable to be turned on or off through the VOR RMMS network. Since the LORMON does not radiate a navigational signal and is protected by a fuse, it is difficult to understand why this requirement is needed. This should be considered a noncritical failure (I:30.1.1.18).

16. The LORMON does not include the new midcontinent chains or the additional station on the Alaskan chain. Without the additional chains and station, the FAA will be unable to support nonprecision approaches based on Loran-C within the middle third of the contiguous U.S. and the southern half of Alaska. This should be considered a critical failure (III:3.2.1.3.8.2.1).

17. The VOR RMMS and LORMON do not identify the Loran-C stations in use by USCG nomenclature. Most publications and the calibration values used for a Loran-C approach refer to the Loran-C stations in standard USCG nomenclature. These calibration values will also be entered into the LORMON. Confusion may result from using different nomenclature. This should be considered a critical failure (LORMON Specification).

18. The M screen accessed from the FCPU VORTAC directory displays an option 11 with a garbled title. The same screen from the RMC-F VORTAC directory does not display the option. Option 11 on the FCPU VORTAC M screen serves no function and should be removed. This could be a source of confusion for an operator and even mistaken as a malfunctioning FCPU. This should be considered a noncritical failure.

19. The LORMON implementation of a MON TEST and CERT TEST are reversed from other equipments in the RMMS network. The FAA systems typically use a Monitor Test to verify that a monitor is functional. A Certification Test is used to verify that the monitor is able to correctly determine when signals are in or out of tolerance. For the LORMON, a Certification Test simply verifies the monitor is functional while the Monitor Test verifies the monitor can correctly determine when signals are in or out of tolerance. To avoid confusion, the LORMON test procedures and results should be consistent with the VOR and TACAN equipment. This should be considered a noncritical failure.

20. Executing a VOR command to copy parameters from monitor 1 to monitor 2 or monitor 2 to monitor 1 (L;9VA or L;9VB) occasionally does not work. The parameters are not copied and a message "TEST GEN SETUP COMPLETE" is displayed. Some of the J PARAMETER SETUP DIRECTORY screens have numerous monitor parameters. A technician can expedite VOR or TACAN monitor setup by copying valid parameters from one monitor to the second monitor. When the COPY command does not function properly, the results and messages are confusing. An FCPU RECYCLE command clears the condition and then "L;9VA" or "L;9VB" will function correctly. The purpose of the command is to facilitate maintenance. Current erratic functioning of the command makes it confusing and counter productive. This should be considered a noncritical failure.

21. Chaining of the J1 LORMON operating parameters is not possible from the RMC-F. Once the first operating parameter is parsed, a communication fault results which terminates further processing of the command. All other J screens will allow chaining of parameters. Chaining of J1 LORMON operating parameters does function properly from the FCPU. The J1 LORMON operating parameter screen contains a significant number of items to be entered. Entering all the parameters without chaining at the RMC-F could be a time-consuming process. Once the LORMON is set up and operating, the parameters will not need to be changed. In most cases, it is expected that the J1 screen will be set at the site using the FCPU IOT which has this capability. The RMC-F and FCPU should be consistent in supporting the chaining of commands. This should be considered a noncritical issue.

22. Changing the controlling VOR monitor does not cause a system state message to be printed on the TTY and the IOT status header does not show an inverse video "V". Status messages do appear when changing the controlling monitor on the TACAN. Status messages for the VOR and TACAN equipments should be consistent. This should be considered a noncritical failure.

23. Entering time with an incorrect format at the RMC-F can hang the port where the command was issued. The time is entered with the H option on the T directory. The system is able to detect when a number is too large for a field and return a prompt. If the operator should forget to include the seconds (i.e., 03/01/03 17:32:) the port of entry will hang. Once hung all further access to the port is terminated. The port will not become active until the power to the RMC-F is turned off and back on. Entering a parameter incorrectly should not cause a port to hang. This condition should be corrected and should be considered a critical failure. (I:3.2.1.1.5.1.H, I:3.2.1.1.9.1.B - As stated earlier, loss of communications with the VOR RMMS or attached equipments for any reason violates other NAS requirements but these are the principle requirements.)

6.8 TEST 8. SUBSYSTEM STATUS REPORTS.

NAS Requirements

I:30.1.1.3	The NAS shall provide subsystem status reports that contain only state changes and alarms/alerts in response to a subsystem status report.
Test Plan #:	3.2.3.2.3
Equipment:	V,D,T,L,R

I:30.1.1.6	The NAS shall provide an alarm when any designated NAS subsystem monitored parameter is out of tolerance.
Test Plan #:	3.2.3.2.6
Equipment:	V,D,T,L,R

I:30.1.1.9	The NAS shall provide a return-to-normal alarm when an initial alarm condition is cleared.
Test Plan #:	3.2.3.2.9
Equipment:	V,D,T,L,R

I:30.1.1.10	The NAS shall provide an alert when selected subsystem parameters are outside a predetermined range.
Test Plan #:	3.2.3.2.10
Equipment:	V,D,T,L,R

Analysis

The addition of the LORMON to the RMMS did not cause the status reports for the VOR, DME, or TACAN to be any different than before the modification. Like the VOR, DME, and TACAN, the LORMON reports alarms on the system state screen (G) and by changing to inverse video the "L" on the status line. Since the LORMON is a single monitor system and all internal components must be functioning correctly for proper operation of the LORMON, it does not require any alert messages. In the October 1989, update to NAS-SS-1000, the requirement for the LORMON to provide an alert when selected subsystem parameters are outside a predetermined range (I:30.1.1.10) was removed. The modified VOR RMMS and LORMON met these NAS requirements.

6.9 TEST 9. LOCAL DATA FILE.

NAS Requirement

I:30.1.1.4	The NAS shall automatically provide for the accumulation of current subsystem status and performance data in a local data file.
Test Plan #:	3.2.3.2.4
Equipment:	V,D,T,L,R

Analysis

This requirement was interpreted to mean that the file will exist in the equipment connected to the VOR RMMS network. To test this requirement, the B Screen (Executive data) was requested from the VOR, TACAN, and LORMON. The request was made from the RMC-F IOT. The G and H screens were also tested. In each case, data pertaining to current subsystem status and performance data were obtained. In the case of the VOR and TACAN, the data was formatted the same as before the Loran modification. The only exception was the addition of the LORMON to the B and G screens. No testing was conducted to determine if the data file was stored at RMC-F. This NAS requirement was met.

6.10 TEST 10. FAIL SAFE DESIGN.

NAS Requirement

III:3.2.1.3.8.1.6	The Loran-C Aviation Monitor shall be fail safe in design, such that a failure of any part(s) of the monitor shall initiate an alarm condition or, as a minimum, shall not cause the monitor to operate nonalarmed with a deteriorated Loran-C signal.
Test Plan #:	3.2.3.3.1.6
Equipment:	L

Analysis

The focus of the test was to determine if the loss of communications with the LORMON would adversely affect the operation of the VOR RMMS network. Testing the LORMON for a fail safe design was conducted during factory acceptance testing and was not repeated. Turning off the LORMON caused the L on the FCPU IOT to display a flashing L in inverse video. This indicated the communications between the FCPU and LORMON was lost. This action did not cause the communications with the VOR or TACAN to be affected. Turning the LORMON power back on corrected the loss of communications signal and indicated a LORMON out of tolerance condition until the monitor properly reacquired the Loran signals. If the LORMON should fail, it is expected that the internal watch dog timer would detect the problem or at the very least communications with the LORMON would be lost. Loss of communications with the LORMON is displayed on the IOT status screen. This NAS requirement was met.

6.11 TEST 11. LORAN MONITORED PARAMETERS.

NAS Requirement

III:3.2.1.3.8.2.3.A-D	The Loran-C Aviation Monitor shall monitor the parameters of the Loran-C signal to within following tolerances:
Test Plan #:	3.2.3.3.2.3

a. Master secondary time difference: resolution 0.1 microsecond (μs), accuracy 0.1 μs; (the LORMON specification requires a resolution of 0.01 μs).

b. Signal-to-noise (S/N) ratio: resolution 1 db, accuracy +/- 1/2 db;

c. Blink Alarm: 95 percent probability of detecting blink alarm within 10 seconds;

d. Loss of signal: 95 percent probability of detecting signal loss within 10 seconds;

Analysis

The addition of the FCPU card will not affect the accuracy of the LORMON or its ability to detect blink alarm or loss of signal within the prescribed time. Testing was conducted to verify that the displayed information had the correct resolution. All screens which displayed time differences and signal-to-noise ratio (SNR) had the proper resolution.

Previous testing of only the LORMON showed that the monitor could not detect a loss of signal under certain conditions. If the SNR reported by the receiver is near 0 dB and the station should go off-air the receiver provides no indication of the event. In time, the position error will tend to grow until the position alarm limit is exceeded at which time an alarm will be issued. The time between loss of signal and an alarm may be long depending on many factors. The LORMON will average all the data for archive purposes during this time period. The monitor also incorrectly reports blink events. If the field strength for any station should be reduced, the Loran-C receiver will report the event as a blink condition. In time, the LORMON will decide this is not a blink and clear the message. Blink is a specific signal imposed by the USCG to alert the users that the signal is on air but out of tolerance. The SNR accuracy was not tested. These problems are a function of the LORMON and not the VOR RMMS network. Good data is required to develop good calibration values. If the LORMON is unable to correctly detect these events, it will archive bad data as well as good data. This should be considered a critical failure (LORMON Spec).

6.12 TEST 12. POWER OUTAGE.

NAS Requirement

III:3.2.1.3.8.2.4	The Loran-C Aviation Monitor shall operate normally during interruptions of external power lasting 30 seconds or less.
Test Plan #:	3.2.3.3.2.4
Equipment:	L

Analysis

The LORMON did not continue to operate when the power plug was removed from the unit. The loss of LORMON front panel information was almost immediately after the external power was removed. No communications were possible with the monitor during this time. Once power was restored, the monitor was able to restart. It was discovered after Integration Testing was completed that the monitor's batteries were bad. Previous informal testing showed that the monitor continued to operate properly when good batteries were used. The duration of proper operation was not measured during the informal testing. Replacement batteries were not available during testing.

The FAULT ISOLATION command was not able to detect the low terminal voltage of the dead batteries. This will be a common failure mode for the batteries and should be detected by the FAULT ISOLATE command. Investigation of the LORMON charging circuitry has revealed that the charging voltage and current are not optimum for long battery life.

AOS-240 has discussed connecting the LORMON to an existing power source at the VORTAC which already has a battery backup. If the power source is available, the internal LORMON batteries can be removed eliminating the problems with charging voltage/current, inability of fault isolate to detect dead batteries, and stocking of additional batteries. This should be considered a critical failure (I:30.1.1.15).

6.13 TEST 13. LOG-ON/SECURITY.

NAS Requirements

I:30.1.1.24	The NAS shall provide for the specialist access to the RMMS network through a maintenance data terminal with the proper authorization.
Test Plan #:	3.2.3.4.1, 3.2.3.2.24
Equipment:	V,D,T,L,R

I:30.1.1.25	The NAS shall provide the capability for local input and display of data, and commands to a subsystem via the maintenance data terminal.
Test Plan #:	3.2.3.2.25
Equipment:	V,D,T,L,R

Analysis

Three levels of security have been implemented into the VOR RMMS network. Each security level allows access to only certain parts of the VOR RMMS network. Since operation of the LORMON will require access by individuals from remote locations and outside the sector, it is important that the security system work as expected.

LORMON's response to commands at each level of security were as expected as noted. It was expected that an operator logged on with lockout security should be able to change parameters on the "CERT GEN SETUP screen, J5". This access was denied. It was also expected that an operator logged on with lockout security should not be able to perform a "K1, Abort Test", "K2, CERT TEST" or "K19, Test Loran Mon". These commands were granted.

One of the primary purposes for modifying the RMC-F and FCPU equipment was to add communications with a LORMON. Communications with the LORMON will be used to determine Loran-C operational status at remote locations and for the collection of Loran-C data in order to produce calibration values. Calibration values will be used by pilots while conducting an approach using Loran-C for landing guidance. An organization called NFOLDS will be tasked with accessing each LORMON in order to determine the calibration values. With a central location needing access to all LORMONs, many regional and sector boundaries will be crossed which leads to many questions concerning security and certification. From the beginning, it was determined that NFOLDS would only require the lowest level of security access, which would allow them to read the Loran data files but not be able to change any of the LORMON operating parameters. Implied in the reasoning was that NFOLDS would not be able to adversely affect the VOR, TACAN, or DME equipment.

As currently implemented, a user logged on at the lowest level of security in the VOR RMMS network is allowed access to two screens which could cause problems with the VORTAC. The screens are L and M. There is a potential for intentional or accidental problems. Present design allows a user, who should only have access to Loran data, the ability to SHUTDOWN the VOR and/or TACAN/DME. Perhaps less of a problem is the ability to turn off the heater/air conditioner, antenna heaters, or obstruction lights. Such a user has the potential to access all VOR sites throughout the entire country using a dial-up modem. This method should be a concern to the various organizations responsible for certification. Listed below are the items which can be accessed from the lowest level of security for the screens:

L screen (Command Maintenance):
1) RESET
2) SHUTDOWN
3) RESTART
4) RECYCLE

M screen (Commands Operator):
1) RESET
2) BLACKOUT
3) MONITOR AURAL
4) RING CALL BELL
5) OBS LIGHTS
6) AIR COND
7) BLDG HEAT
8) SELECT RCO
9) SPARE
10) ANT. HEATERS

This is not a technical problem with the modifications and does not affect the correct operation of the VOR RMMS network. It is a potential operational problem. At present, many Flight Service Stations (FSS) already have this capability and cross sector boundaries. Since NFOLDS will be operated by only a small number of government personnel, the risk should not be significantly greater than exists today.

If it is later determined that this is a significant operational problem, two possible solutions should be considered. One method would be to separate the LORMON access from VORTAC access. This could be accomplished by adding the LORMON to the T screen. The other method would be to remove all access to the commands appearing on the L and M screen from first level access.

6.14 TEST 14. MULTI-USER COMPATIBILITY.

NAS Requirement

I:30.1.1.26	The NAS shall provide the specialist the capability to obtain exclusive control of a subsystem while onsite.
Test Plan #:	3.2.3.4.5, 3.2.3.2.26
Equipment:	V,D,T,L,R

Analysis

The intent of this section was to address the effects of different people using the VOR RMMS network. The following questions were addressed:

1. How does the system function with one person on the IOT and another on the dial-up modem? This question applies to the RMC-C and FCPU.

2. Who has control of the equipment? Can someone at the FCPU deny access to someone at the RMC-F? This would be important if a technician were at the site working on equipment.

Only one user has exclusive control of a subsystem at a time. This is only true for the VOR RMMS network. Once a specialist is validly logged onto a subsystem, all other users from other points of entry trying to access that same subsystem are locked out. A message is displayed that the subsystem is in use. If the logged-on user requests a Loran archive data file, the user is automatically logged off of the subsystem once the data starts to be displayed. This makes the site available for access from another point of entry.

Automatic log-off was also tested. Automatic log-off at the RMC-F IOT port occurred 21 minutes, 12 seconds after lack of user activity. Lack of activity at the FCPU IOT caused automatic log-off after 20 minutes, 9 seconds. When the RMC-F Modem port was idle for 5 minutes, 28 seconds, the operator was automatically logged off the system.

As implemented in Version 1.11 of the LORMON firmware, a user does have exclusive control of the LORMON while at the site. An internal switch enables or disables the FCPU port of the LORMON but the IOT port is always activated. The switch is only read at power up which means LORMON power must be recycled. When both the IOT and FCPU ports of the LORMON are active, no arbitration has been provided for the ports. The LORMON meets this NAS requirement.

6.15 TEST 15. INSTALLATION PROBLEMS.

NAS Requirements

No NAS requirements have been identified which specifically address installation issues. Lack of proper hardware for installation, poor cable strain reliefs, and poor cable labeling will make the FCPU modification a potential problem. The major problem is a safety issue concerning the strain relief attached to bracket 093977-001. Installation of this strain relief will cause an electrical short of a circuit breaker. This should be considered a deployment critical issue. Productions kits are said to have eliminated these problems, but have not been observed by the Technical Center.

6.16 LORMON RELATED.

6.16.1 Introduction.

The purpose of the tests reported in this document were to verify that LORMON information could be correctly transmitted through the FCPU to the RMC-F, and that transmission of VOR and TACAN data through the same system was not adversely effected. While the testing did accomplish this goal in a general sense, separate tests were conducted to study the LORMON in detail. Testing of the LORMON started with the delivery of the system September 1988.

Since its delivery, the LORMON firmware has been changed at least seven times. The changes were based on Technical Center identified problems. The problems were transmitted to the Program Office through numerous informal reports, letters, and technical interchange meetings. Since the configuration of the LORMON was constantly changing, no single document has been published which describes all the testing.

For the most part, the problems identified by this separate testing will not affect the integration of the LORMON with the VOR RMMS network. Integration will only be affected under certain conditions (noisy communication lines or lost communication lines). The problems are operationally significant. The effect will be on maintenance support and quality of data supplied to NFOLDS.

6.16.2 LORMON FCPU Port.

1. Error detection and recovery, including "break" detection and processing, was not consistent with the ICD. No version of monitor software through 1.11 (delivered 5/8/90) has implemented full error detection and recovery procedures as described in paragraphs 7.0 through 7.2 of the ICD. In particular, the monitor did not handle break processing or messages with shorter than expected records. The LORMON always expected the word (byte) count included in the message and the number of words transmitted would be the same. Under ideal conditions, the two should be the same. If the VOR RMMS should send a "bad" message or the message should get garbled during transmission, the LORMON could stop communicating. Since the message from the FCPU to the LORMON should travel only a short distance (less than 20 feet) garbled messages should be few. This condition is detectable if the intercharacter gap check was properly implemented. Error recovery based on FCPU-detected errors was not implemented in monitor software. While this should not be a problem in most sites, some sites may be noisy so, therefore, this should be considered a critical issue (LORMON ICD).

2. The monitor does not provide a positive response to all transmissions from the FCPU. Without a positive response to every command, it is difficult to know that a command/message has been received by the LORMON. There are indirect methods to determine if a command/message was not received correctly. If the LORMON is working correctly, it should respond to the FCPU when a bad message is received. If the communications should be lost between the FCPU and LORMON, no messages would be received. The present implementation of the VOR RMMS seems to work without this feature. Proper operation is implied by lack of information rather than by a positive response. This should be considered a critical issue (LORMON ICD).

3. The EOF status found in some archive data files does not agree with the EOF found in the status header. If the system was still in the development stage, this could present a problem. Since the VOR RMMS is already able to access the archive data, the impact is small. To help future developers, the LORMON ICD should be changed or the LORMON should be made to work to the ICD. This should be considered a noncritical issue (LORMON ICD).

4. The executive alarm bit is only set when the measured parameters are out of tolerance or during certain testing. The bit is not always set when the receiver is in acquisition. The present methodology makes it difficult to determine when the receiver is in Normal track using the antenna (Normal operating mode). The executive alarm bit should be set whenever the LORMON is not in Normal track, with all parameters in tolerance and receiving signals from the antenna. This should be considered a critical issue (LORMON ICD).

5. The monitor busy bit does not get set and remain set when the LORMON is busy. For example, when archive data is requested the busy bit should remain set until the LORMON is ready to send the data. Since the archive data must be polled in order to obtain the data, the FCPU must wait for the LORMON to get ready before issuing the command. Without the busy bit being set correctly, the FCPU delay must have been set by trial and error. This method would increase the time required to obtain the data. Another problem is that the monitor busy bit received from the Status Only request and the same information when part of a message do not always agree. The current implementation of the FCPU has worked around these problems and appears to function properly. For future developers, the busy bit should be set correctly. This should be considered a noncritical issue (LORMON ICD).

6.16.3 Basic LORMON.

1. Inconsistent formatting of information sent to the IOT port of the LORMON. While the information is correctly formatted on the standard FAA terminal, it is incorrectly formatted for a PC. The formatting problems result from extra lines being printed. Extra lines are printed due to the number of characters per line and the end of line termination. If the standard FAA terminals were replaced, this could be a potential problem. This should be considered a noncritical issue.

2. Notch filter status is not provided to the operator. Notch filters are automatically tuned by the Loran receiver to remove undesired signals. In most sites, the notch filter will operate correctly. At a problem site, notch filter information can be very important to isolating the problem. This should be considered a noncritical issue.

3. Acquisition or Normal track status is only available on the front panel of the LORMON. When operating the LORMON from a remote location, it will not be possible to obtain this information. If the LORMON receiver is taking a long time to go out of Executive Alarm, determining the reason may be difficult. Even if the front panel information is available on the VOR RMMS, it may still be difficult to determine a reason. Detailed receiver acquisition status is available from the receiver but has not been incorporated into the LORMON. Additional information would allow an operator to know if the receiver keeps cycling through the various steps or is stuck at a particular step. It would also be able to determine if the problem were a single station or multiple stations. This should be considered a critical issue.

4. All Loran archive data files include the Loran-C position as averaged time differences (TD's). The Executive Data screen shows a real-time Loran-C position as an offset in nmi from a reference point. It is not possible to compare the data in the archive files with real-time values. While the position offset is a measure

of the difference between the measured TD's and the TD's for the reference point, it is not in the same units as the archive data. To make it easier to compare archive data with real-time data, TD values which correlate with the position offset found on the Executive Data screen should be available for review. This should be considered a noncritical issue.

5. LORMON handling of archive data is less than ideal. As currently implemented, the LORMON does produce archive data which on the surface appears to be correct. The appearance can be misleading, however. The LORMON averages all data unless the receiver is in acquisition. Data obtained before the receiver is in Normal track, using the antenna, will be in error. During times of acquisition, the LORMON loses the ability to properly time tag the archive data. Since the LORMON uses the number of samples to determine when a particular time slot is full, the time slot may include data collected over several days instead of just 10 minutes or 4 hours. Time for each time slot is based on knowing the time for the most recent sample and indexing back. Indexing assumes each entry only took 10 minutes or 4 hours to collect. Start time for archiving data is a function of turn-on and, therefore, data obtained from different monitors will not be in sync. It can be argued that NFOLDS will be looking at data collected over a long period of time and, therefore, short periods of bad data will have little effect on the correction value produced. Bad data could therefore be excluded. At some point, the effect of bad data can become a problem. Testing has been conducted to determine the range of validity of each LORMON. Testing was limited to New England. During the early phase of implementation, there were plans to analyze data from adjacent LORMONs to study range of validity in other parts of the country. Without archive data, that is correlated from the various LORMONs, it will be difficult to study the effect. NFOLDS has currently implemented methods to work around the bad time tags in the archive data and filter some of the bad data. Methods to provide time synchronization between LORMONs have not been implemented. The work arounds are enabling NFOLDS to obtained Loran archive data from a limited number of LORMONs but requires additional processing time. This should be considered a critical issue.

6. The LORMON and airborne Loran-C receivers use the World Geodetic System of 1972 (WGS-72) when computing geodetic positions. All FAA charting was in the North American Datum of 1927 (NAD-27). Differences in the absolute geodetic position between the two datums can be significant. Methodologies were in place to compensate for differences in the datums when calculating the calibration values. The FAA has recently changed all charting to the North American Datum of 1983. Since we will once again have two different datums, the same concerns will continue to exist. The methodologies to compensate for the differences must once again be implemented. This should be considered a critical issue.

7. Water leaking into the LORMON antenna coupler has been reported at two field sites. The antenna coupler stops functioning once the water shorts out the cables. In at least one case, the water has dissolved parts of the printed circuit card in the antenna coupler. Two leaking antenna couplers out of 196 deployed units are not very significant! Not known is how many of the units are actually turned on and being closely checked. Since the water leak causes the antenna coupler to stop functioning, it will have a major effect on the LORMON's ability to receive Loran-C signals. If the leak is a widespread problem it could result in not having enough replacement units to support the field. This should be considered a critical issue.

8. The "CLEAR ARCHIVES and INSTALL DEFAULTS" can only be executed from the LORMON IOT. If the command is accidentally chosen, there is no way to abort the command. Once the command is executed, the archives are cleared and the LORMON uses default operating parameters. Clearing the archives means that 60 days of data will be erased and NFOLDS will have no data to analyze. Without data for NFOLDS to analyze they will not be able to compute a calibration value for all approaches which use that monitor. Without calibration values, the approaches will not be authorized. Since this command is not supported by the VOR RMMS, the only way to clear the archives will be to connect a terminal to the IOT port of the LORMON. While the risk may be reduced because of limited access to the command, it should still be considered a critical issue.

9. The J PARAMETER SETUP DIRECTORY has two titles which differ from the title on the subscreen. The J PARAMETER SETUP DIRECTORY shows the J5 subscreen as TEST GEN SETUP, but the J5 subscreen is titled LORAN CERT GEN. A similar condition exists for the J9 subscreen. From the J PARAMETER SETUP DIRECTORY, J9 is titled as MONITOR CERT SETUP, but the J9 subscreen is titled LORAN MON TEST SETUP. Since MON TEST and CERT TEST are two valid test commands, it is unclear which test is being set up. The titles are in conflict and are therefore a source of confusion. This should be considered a critical issue.

10. The Monitor By-Pass bit gets set if CERT TEST is entered automatically from Fault Isolate, but does not get set if CERT TEST is entered directly. The Monitor By-Pass bit should be consistent and used by the LORMON to exclude data from the archives. This should be considered a critical issue.

11. The function of the Monitor BY-PASS ENABLE command is unclear. The ICD states the Monitor By-Pass bit is set whenever the Loran receiver is switched to the internal Loran-C simulator. Also stated in the ICD is that the archival functions shall still operate as long as the LORMON is receiving data from the Loran-C receiver board. Placing a monitor into the By-Pass mode generally means data from the monitor is unreliable due to some maintenance function and should be ignored. While in the By-Pass mode, an Executive Alarm should be active but an operator should not become concerned if any parameters are out of tolerance. At the very least, issuing a LORMON BY-PASS ENABLE should set the By-Pass bit and stop archival functions. Whether the command should also switch the LORMON to the internal simulator is not so clear. This should be considered a critical issue since the use of the Monitor BY-PASS command could effect the archive data.

6.17 SUMMARY OF ANALYSIS.

The LORMON and modified VOR RMMS network did not meet all of the NAS or LORMON requirements. Table 6.17-1 is a summary of the NAS or LORMON requirements evaluated. The table lists which requirements were met and those that failed. Requirements which were not met are identified as noncritical or critical. Those items which are identified as critical, need to be fixed. The noncritical category is composed of those requirements which the modified RMMS did not meet, but there is no foreseeable threat to safety or operations.

TABLE 6.17-1. SUMMARY OF REQUIREMENTS EVALUATED

NAS REQUIREMENT	TEST #	DESCRIPTION	STATUS		
			PASS	FAIL Crit.	FAIL Non-Crit.
I:3.2.1.1.5.1.H	7	General Commands: VOR, TACAN, Loran Monitor, RMMS		X	
I:3.2.1.1.5.1.J	7	....	X		
I:3.2.1.1.9.1.A-C	7	....		X	
I:3.2.1.1.9.1.D	7	....		X	
*I:3.2.1.1.9.1.D	12	Power Outage		X	
I:3.2.1.1.9.1.E-F	7	General Commands: VOR, TACAN, Loran Monitor, RMMS	X		
I:3.2.1.1.9.1.G	7	....		X	
I:3.2.1.2.5.H	1	Equipment Shutdown/Time to Report Status	X		
I:3.2.1.2.5.I	1	....	X		
I:3.2.1.2.5.K	2	Time to Report Loran Monitor Operational Status	X		
I:3.2.1.2.9.A	7	General Commands: VOR, TACAN, Loran			
I:3.2.1.2.9.B	3	Time to Detect and Present: Alarms and State Changes	X		
I:3.2.1.2.9.C	4	Control Command Execution Time			X
I:3.2.1.2.9.D	5	Presentation of Requested Information	X		
I:3.2.1.2.9.E	6	Acknowledgement of Test Command			X
I:30.1.1.1	7	General Commands: VOR, TACAN, Loran Monitor, RMMS	X		
I:30.1.1.2	7	....		X	
I:30.1.1.3	8	Subsystem Status Reports	X		
I:30.1.1.4	9	Local Data File	X		
I:30.1.1.5	7	General Commands: VOR, TACAN, Loran Monitor, RMMS		X	
I:30.1.1.6	8	Subsystem Status Reports	X		
I:30.1.1.7-8	7	General Commands: VOR, TACAN, Loran Monitor, RMMS			X
I:30.1.1.9	8	Subsystem Status Reports	X		
I:30.1.1.10	8	....	X		
I:30.1.1.11-14	7	General Commands: VOR, TACAN, Loran Monitor, RMMS	X		
I:30.1.1.15	7	....	X		
*I:30.1.1.15	12	Power Outage		X	
I:30.1.1.16-18	7	General Commands: VOR, TACAN, Loran Monitor, RMMS			X
I:30.1.1.19-20	7	....	X		
I:30.1.1.21-23	7	....			X
I:30.1.1.24	7	....	X		
I:30.1.1.24	13	Log-On Security	X		
I:30.1.1.25	13	....	X		
*I:30.1.1.26	7	General Commands: VOR, TACAN, Loran Monitor, RMMS		X	
I:30.1.1.26	14	Multi-User Compatibility	X		
III:3.2.1.3.8.1.4	14	....	X		
III:3.2.1.3.8.1.5	14	....	X		
III:3.2.1.3.8.1.6	10	Fail Safe Design	X		
III:3.2.1.3.8.1.8	7	General Commands: VOR, TACAN, Loran Monitor, RMMS	X		
III:3.2.1.3.8.1.9	7	....	X		
*III:3.2.1.3.8.1.4	7	....		X	
III:3.2.1.3.8.2.1	7	....		X	
III:3.2.1.3.8.2.4	12	Power Outage	X		
III:3.2.1.3.8.2.3.A-D	11	Loran Monitored Parameters	X		
III:3.2.1.3.8.3	7	General Commands: VOR, TACAN, Loran Monitor, RMMS		X	
*LORMON Spec.	7	Loran Monitor - Specification & ICD		X	
*LORMON Spec.	11	Loran Monitored Parameters		X	
*LORMON Spec.	16	LORMON General Test		X	
*LORMON ICD	7	Loran Monitor - Specification & ICD		X	
*LORMON ICD	16	LORMON General Test		X	
	15	Pre-production Modification Kit		@	

NOTES:

* = NAS requirement not cited for this test in original Test Plan
@ = Deployment Critical

7. CONCLUSIONS.

The LORMON and modified Very High Frequency Omnidirectional Range (VOR) Remote Maintenance Monitoring System (RMMS) did not meet all the National Airspace System (NAS) requirements, Loran-C Aviation Monitor (LORMON) Specification, or LORMON Interface Control Document (ICD). One item was defined to be deployment critical, 22 items were identified as critical, and 20 items were identified as noncritical. Those items defined as critical must be fixed while noncritical items need to be reviewed.

The sections that follow list the items identified as not meeting the requirements. A brief description of each problem is presented below. In parentheses, following a brief description of the problem, will be the test number where the problem was identified and the requirement not being met. NAS requirements could not be found for all failures.

7.1 DEPLOYMENT CRITICAL.

Only one item was identified as deployment critical. That item was the preproduction FCPU modification kit hardware. The preproduction FCPU modification kit lacked complete hardware to finish the installation, labeling of the interconnecting cables was inadequate, the cable strain reliefs were inadequate, and the strain relief to mount on terminal bracket (093977-001) is a safety hazard. Installation of this strain relief will cause an electrical short of a circuit breaker. Production kits allegedly exist which do not have this problem, however, these kits have not been supplied to the Federal Aviation Administration (FAA) Technical Center.

7.2 CRITICAL.

7.2.1 VOR RMMS

1. Interruption of the phone connection during the downloading of Loran archive data from the RMC-F dial-up modem port can deny further access to the LORMON archive data from all ports (Test 7, I:3.2.1.1.9.1 C, I:3.2.1.1.9.1 G, I:30.1.1.26, III:3.2.1.3.8.1.4, III:3.2.1.3.8.3).

2. It is not possible to obtain Loran archive data selected by date/time and number of records from the dial-up modem port of the RMC-F (Test 7, III:3.2.1.3.8.3, Loran Monitor ICD).

3. Executive Alarm status is inconsistent. The LORMON Executive Alarm status obtained from the LORMON front panel did not always agree with information obtained through the FCPU port of the LORMON, or LORMON IOT port (Test 7, III:3.2.1.3.8.3, LORMON Spec.).

4. Once a LORMON Fault Isolation command is issued, communications with the FCPU port of the LORMON is not possible for approximately 5 minutes. (Test 7, I:3.2.1.1.9.1.A, I:3.2.1.2.9.A - Loss of communications with the VOR RMMS or attached equipments for any reason violates other NAS requirements but these are the principle requirements.)

5. Aborting a LORMON FAULT ISOLATE COMMAND produces an incorrect system state message (Test 7, I:30.1.1.2).

6. Issuing a LORMON BY-PASS command from the FCPU IOT port during the downloading of LORMON archive data produces an incorrect LORMON system state (Test 7, I:30.1.1.2).

7. The LORMON does not support the new midcontinent chains or the additional station in Alaska (Test 7, III:3.2.1.3.8.2.1).

8. The VOR RMMS and LORMON do not identify the Loran-C stations in use by United States Coast Guard (USCG) nomenclature (Test 7, LORMON Specification).

9. Entering time with an incorrect format at the RMC-F can hang the port where the command was issued. (Test 7, I:3.2.1.1.5.1.H, I:3.2.1.1.9.1.B - As stated earlier, loss of communications with the VOR RMMS or attached equipments for any reason violates other NAS requirements but these are the principle requirements.)

10. The LORMON is not able to detect loss of Loran-C station and incorrectly reports blink under certain conditions (Test 11, LORMON Spec.).

11. The LORMON is not able to handle power outage. Dead batteries in LORMON were not detectable by FAULT ISOLATE command. Charging voltage and current for the batteries are considered questionable (Test 12, I:30.1.1.15, I:3.2.1.1.9.1.D).

7.2.2 LORMON FCPU Port.

1. Error detection and recovery, including break detection and processing, was not consistent with the ICD. In particular, the monitor did not handle break processing or messages with shorter than expected records (LORMON ICD).

2. The monitor does not provide a positive response to all transmissions from the FCPU (LORMON ICD).

3. The executive alarm bit is not set correctly (LORMON Spec. and ICD).

7.2.3 Basic LORMON.

1. Acquisition or Normal track status are only available on the front panel of the LORMON.

2. The LORMON handling of archive data is not adequate.

3. The LORMON does not use the FAA standard geodetic reference system.

4. Waters leaks into the LORMON antenna coupler.

5. CLEAR ARCHIVES and INSTALL DEFAULTS commands can only be executed from the LORMON IOT and is executed immediately upon selection with no intermediate screen.

6. Titles on J screen are inconsistent with titles on the J5 and J9 screens.

7. The Monitor By-Pass bit is not set consistently.

8. Function of LORMON BY-PASS command is unclear.

7.3 NONCRITICAL.

7.3.1 VOR RMMS.

1. Time to execute control commands exceeded the average time requirement of 5 seconds by 1.0 second. The largest single time was 9 seconds, which is well within the 15 seconds (99th percentile) requirement (Test 4, I:3.2.1.2.9.C).

2. The average time for the NAS to provide an acknowledgement to a specialist of a subsystem's receipt of a valid test command, that was input by a specialist, exceeded the 15-second requirement. The average time exceeded the limit by 1.4 to 3.2 seconds (Test 6, I:3.2.1.2.9.E).

3. VOR RMMS network does not automatically download date and time to the LORMON under certain conditions. LORMON will not go into acquisition unless the date and time are set (Test 7).

4. When downloading the Loran .rchive data, access to the LORMON is limited (Test 7, I:30.1.1.21, I:30.1.1.22).

5. When downloading the Loran archive data to the RMC-F dial-up port, a user at another VOR RMMS port can terminate the transfer (Test 7).

6. The RMC-F IOT port lists the J9 screen as Loran Monitor CERT TEST when viewed from the J screen and as a Loran Monitor Test when viewed from the J9 screen (Test 7).

7. The following screens are confusing: L(2, 3, 4, 7, 8, 9, 10), K(3, 4, 6), and J(1, 2, 3). The confusion involves the LORMON (Test 7).

8. The LORMON does not provide control of electrical power, heat ventilation air conditioning (HVAC), or smoke, fire, intrusion detection (Test 7, I:30.1.1.7, I:30.1.1.8, I:30.1.1.23).

9. The LORMON is unable to be turned on or off through the VOR RMMS network (Test 7, I:30.1.1.18).

10. The M screen accessed from the FCPU VOR Tactical Air Navigation (TACAN) (VORTAC) directory displays an option 11 with a garbled title (Test 7).

11. The LORMON implementation of a MON TEST and CERT TEST are reversed from other equipments in the RMMS network (Test 7).

12. Executing a VOR command to copy parameters from monitor 1 to monitor 2 or monitor 2 to monitor 1 ("L;9VA" or "L;9VB") occasionally does not work (Test 7).

13. Chaining of the J1 LORMON operating parameters is not possible from the RMC-F (Test 7).

14. Changing the controlling VOR monitor does not cause a system state message to be printed on the Teletype (TTY) and the IOT status header does not show an inverse video "V" (Test 7).

15. LORMON's response to CERT GEN SETUP ("J5"), Abort Test ("K1"), CERT TEST ("K2"), and Test Loran Mon ("K19") were not as expected at lockout level of security. Ability to change parameters of J5 screen when a lockout level of security was denied and access was granted for the rest of the commands listed above. This was opposite to what was expected. Access to the Loran archive data files through the VOR RMMS is allowed at the lowest level of security. Access at this level allows shutdown or resetting of certain VORTAC equipment. With this arrangement NFOLDS would be able to control the following functions on the entire VORTAC facility: RESET, SHUTDOWN, RESTART, RECYCLE, BLACKOUT, OBS LIGHTS, AIR COND., BLDG. HEAT, AND ANTENNA HEAT. This could be an operational problem since NFOLDS will have access to all sites (Test 13, I:30.1.1.24).

7.3.2 LORMON FCPU Port.

1. The end-of-file (EOF) status found in some archive data files does not agree with the EOF found in the status header (LORMON ICD).

2. The monitor busy bit does not get set and remain set when the LORMON is busy (LORMON Spec. and ICD).

7.3.3 Basic Loran-C Monitor.

1. Inconsistent formatting of information sent to the IOT port of the LORMON.

2. Real-time differences are not available.

3. Notch filter status is not provided to the operator.

8. RECOMMENDATIONS.

The identified deployment critical item must be addressed prior to deployment. This deficiency must be corrected or a plan of corrective action implemented prior to actual deployment. A plan must also be put in place to handle the 22 items identified as critical. Additionally, correction of the noncritical items would provide a more useful LORMON and Very High Frequency Omnidirectional Range (VOR) Remote Maintenance Monitoring System (RMMS).

9. ABBREVIATIONS AND ACRONYMS.

ACN	FAA, Technical Center Engineering, Test and Evaluation Service
APME	Associate Program Manager Engineering
ASM	FAA, Systems Maintenance Service
CCA	Circuit Card Assembly
dB	decibel
DME	Distance Measuring Equipment
DOD	Department of Defense
EEM	Electronic Equipment Modifications
EOF	End-of-File
EPROM	Electrically Programmable Read Only Memory
FAA	Federal Aviation Administration
FCPU	Facility Central Processing Unit
FOVT	Field Operational Verification Test
HVAC	Heat Ventilation Air Conditioning
ICD	Interface Control Document
IOT	Input/Output Terminal
LORMON	Loran-C Aviation Monitor
μs	microsecond
NAS	National Airspace System
NFOLDS	National Field Office Loran Data Systems
nmi	nautical mile
NREC	Number of Records
OT&E	Operational Test and Evaluation
PC	personal computer
RMC-C	Remote Monitor and Control Processing Unit Type C

RMC-F	Remote Monitor and Control Processing Unit Type F
RMMS	Remote Maintenance Monitoring System
S/N	Signal-to-Noise
SNR	Signal-to-Noise Ratio
TACAN	Tactical Air Navigation
TD	time difference
T&E	Test and Evaluation
TTY	Teletype
USCG	United States Coast Guard
VDC	volts direct current
VOR	Very High Frequency Omnidirectional Range
VORTAC	VOR TACAN

APPENDIX A

COMMANDS EXECUTED ON THE RMMS SYSTEM

This appendix contains each of the commands executed on the RMMS system during integration testing. Commands were randomly executed at one of the following ports: FCPU IOT, FCPU TTY/PRINTER, FCPU DIAL-UP MODEM, RMC-F IOT, RMC-F TTY/PRINTER, and RMC-F DIAL-UP MODEM. Each command was executed at least once from one of the ports in the network.

EQUIPMENT: VOR

SCREEN #/NAME	POINT OF ENTRY / PORT	FCPU IOT	FCPU TTY/PRINTER	FCPU MODEM	RMC-F IOT	RMC-F TTY/PRINTER	RMC-F MODEM
B MONITOR EXEC DATA	MON1			X			X
	MON2	X		X			
C FAULT HISTORY	MON1			X			
	MON2			X	X		
D MONITOR CERT DATA	MON1		X	X			
	MON2			X			
E TRANS CERT DATA	MON1			X			
	MON2	X					
F GROUND CHECK DATA	MON1				X		
	MON2			X			
G SYSTEM STATUS			X	X			
H MAINTENANCE ALERTS		X	X	X	X	X	X
I MAINTENANCE DATA DIRECTORY		X	X	X	X	X	X
1 VOR TREND				X	X		X
2 VOR MON1 TEST			X	X			
3 VOR MON2 TEST		X		X			
4 VOR FAULT ISOLATE		X		X			
5 VOR DIAGNOSTICS				X		X	
J PARAMETER SETUP DIRECTOR		X	X	X		X	
1 OPERATING PARAMETERS	MON1			X			
	MON2	X		X			
2 MONITOR ALARM LIMITS	MON1				X	X	
	MON2		X	X			
3 TRANS CERT LIMITS	MON1			X			
	MON2			X		X	
4 VOR MONITOR CERT SETUP				X		X	
5 TEST GEN SETUP					X		
7 CODE CHANGE			X				
K COMMANDS RUN TESTS		X	X	X	X	X	
1 ABORT TEST				X	X		
2 CERT TEST			X	X			
3 TREND DATA						X	
4 FAULT ISOLATE TRANS			X				
5 FAULT ISOLATE MON1			X				
6 FAULT ISOLATE MON2			X	X			
8 GROUND CHECK VOR						X	
9 TEST VOR MON1					X		
10 TEST VOR MON2						X	
11 VOR DIAGNOSTICS		X		X			
L COMMANDS MAINTENANCE *		X		X	X	X	
1 RESET		X		X			
2 SHUTDOWN		X		X			
3 RESTART		X		X			
4 RECYCLE						X	
6 MONITOR BY-PASS (SET/CLR)					X		
7 MONITOR CONTROLLER	MON1				X	X	
	MON2				X	X	
8 REDUND MONITOR ENABLE (ENABLE/DISABLE)					X		
9 COPY MONITOR PARAMETERS	1 TO 2					X	
	2 TO 1				X		
M COMMANDS OPERATOR				X		X	
1 RESET				X		X	
2 BLACKOUT						X	
N ACKNOWLEDGE ALARM						X	

* Only L screen options 1 through 4 are displayed at PASSWORD & LOCKOUT levels of security.

EQUIPMENT: TACAN

SCREEN #/NAME	POINT OF ENTRY PORT	FCPU IOT	FCPU TTY/PRINTER	FCPU MODEM	RMC-F IOT	RMC-F TTY/PRINTER	RMC-F MODEM
B MONITOR EXEC DATA	MON1		X	X			X
	MON2			X			
C FAULT HISTORY	MON1			X			
	MON2					X	
D MONITOR CERT DATA	MON1	X	X				
	MON2			X	X		
E TRANS CERT DATA	MON1		X				
	MON2			X			
F GROUND CHECK DATA	MON1	X					
	MON2						
G SYSTEM STATUS				X		X	X
H MAINTENANCE ALERTS		X	X	X	X	X	X
I MAINTENANCE DATA DIRECTORY							
11 TAC/DME TREND		X	X				
12 TAC/DME SPECIAL TESTS		X	X				
13 TAC/DME FAULT ISOLATE		X	X				
J PARAMETER SETUP DIRECTOR		X	X	X	X	X	
1 OPERATING PARAMETERS	MON1		X	X			
	MON2				X	X	
2 MONITOR ALARM LIMITS	MON1				X	X	
	MON2	X					
3 TRANS CERT LIMITS	MON1				X	X	
	MON2			X		X	
5 TEST GEN SETUP					X		
7 CODE CHANGE				X	X		
8 TAC/DME DIODE FACTORS				X	X		
K COMMANDS RUN TESTS		X	X	X	X		
1 ABORT TEST				X	X		
2 CERT TEST			X	X			
3 TREND DATA				X	X		
4 FAULT ISOLATE TRANS		X					
5 FAULT ISOLATE MON1		X					
6 FAULT ISOLATE MON2		X					
15 TRANS TEST TAC/DME					X		
16 RCVR SELECTIVITY TAC/DME				X	X		
17 MIG TEST TAC/DME					X		
18 AZ ACQ TAC/DME					X		
L COMMANDS MAINTENANCE *			X	X	X	X	X
1 RESET			X	X			
2 SHUTDOWN			X	X			
3 RESTART			X	X			
4 RECYCLE					X		
6 MONITOR BY-PASS (SET/CLR)						X	
7 MONITOR CONTROLLER	MON1				X	X	
	MON2					X	
8 REDUND MONITOR ENABLE (ENABLE/DISABLE)						X	
9 COPY MONITOR PARAMETERS	1 TO 2		X				
	2 TO 1				X	X	
10 IDENT (ON/OFF)					X		
15 TAC/DME TEST MODE				X	X		
16 TAC/DME MODE				X	X		X
M COMMANDS OPERATOR							
1 RESET						X	
2 BLACKOUT						X	X
N ACKNOWLEDGE ALARM						X	

* Only L screen options 1 through 4 are displayed at PASSWORD & LOCKOUT levels of security.

EQUIPMENT: LORAN

	FCPU			RMC-F		
POINT OF ENTRY / PORT	IOT	TTY/ PRINTER	MODEM	IOT	TTY/ PRINTER	MODEM
SCREEN #/NAME						
B MONITOR EXEC DATA	X	X	X	X	X	X
C FAULT HISTORY	X	X	X	X	X	X
D MONITOR CERT DATA	X	X	X	X	X	X
G SYSTEM STATUS	X	X	X	X	X	X
I MAINTENANCE DATA DIRECTORY	X	X	X	X	X	X
14 LORAN FAULT ISOLATE	X	X	X	X	X	X
15 LORAN MON TEST	X	X	X	X	X	X
16 LORAN 10 MINUTE AVERAGE	X	X	X	X	X	X
17 LORAN 4 HOUR DATA	X	X	X	X	X	X
18 LORAN BLINK DATA	X	X	X	X	X	X
19 LORAN 1 SECOND DATA	X	X	X	X	X	X
20 LORAN 1 MINUTE DATA	X	X	X	X	X	X
J PARAMETER SETUP DIRECTORY	X	X	X	X	X	X
1 OPERATING PARAMETERS (READ)	X	X	X	X	X	X
1 OPERATING PARAMETERS (WRITE)	X	X	X	X	X	X
2 MONITOR ALARM LIMITS (READ)	X	X	X	X	X	X
2 MONITOR ALARM LIMITS (WRITE)	X	X	X	X	X	X
5 TEST GEN SETUP (READ)	X	X	X	X	X	X
5 TEST GEN SETUP (WRITE)	X	X	X	X	X	X
9 LORAN MON TEST SETUP (READ)	X	X	X	X	X	X
9 LORAN MON TEST SETUP (WRITE)	X	X	X	X	X	X
10 FUTURE LORAN TD (READ)	X	X	X	X	X	X
10 FUTURE LORAN TD (WRITE)	X	X	X	X	X	X
K COMMANDS RUN TESTS *	X	X	X	X	X	X
1 ABORT TEST	X	X	X	X	X	X
2 CERT TEST	X	X	X	X	X	X
5 FAULT ISOLATE MON1	X	X	X	X	X	X
19 TEST LORAN MON	X	X	X	X	X	X
L COMMANDS MAINTENANCE	X	X	X	X	X	X
1 RESET	X	X	X	X	X	X
6 MONITOR BY-PASS (SET/CLR)	X	X	X	X	X	X
M COMMANDS OPERATOR	X	X	X	X	X	X
1 RESET	X	X	X	X	X	X

* access was not granted to K screen commands at PASSWORD level of security

EQUIPMENT: RMMS

SCREEN #/NAME		FCPU IOT	FCPU TTY/ PRINTER	FCPU MODEM	RMC-F IOT	RMC-F TTY/ PRINTER	RMC-F MODEM
POINT OF ENTRY / PORT		IOT	TTY/ PRINTER	MODEM	IOT	TTY/ PRINTER	MODEM
I FCPU / RMC-F DIRECTORY							
A VORTAC DIRECTORY		X	X	X	X	X	X
G SYSTEM STATUS		X	X	X	X	X	X
H MAINTENANCE ALERTS		X	X	X	X	X	X
I MAINTENANCE DATA DIRECTORY			X	X	X		
6 FCPU FAULT ISOLATE			X	X	X		
7 RCO TEST	*						
8 ENG GEN TEST	*						
9 ENV SENSORS ANALOG	*						
10 ENV SENSORS DISCRETE	*						
J PARAMETER SETUP DIRECTORY			X	X	X	X	
6 FCPU PARAM			X	X		X	
7 CODE CHANGE			X		X		
K COMMANDS RUN TESTS					X	X	
7 FAULT ISOLATE FCPU					X	X	
12 TEST RCO	*						
13 SCAN ENV SENSORS	*						
14 ENG GEN TEST	*						
L COMMANDS MAINTENANCE		X	X	X	X	X	
5 ENG GEN	*						
10 IDENT					X		
11 RECORD VOICE					X		
12 FCPU RECYCLE		X			X		
13 ENTER SPECIAL TESTS MODE			X	X	X		
14 SELECT CODER/DECODER			X			X	
M COMMANDS OPERATOR							
3 MONITOR AURAL	*						
4 RING CALL BELL	*						
5 OBS LIGHTS	*						
6 AIR COND	*						
7 BLDG HEAT	*						
8 SELECT RCO	*						
9 SPARE 1							
10 SELECT VOR AND SOURCE	*						
11 ANTENNA HEATERS	*						
B FCPU STATUS				X			
C RMC-F STATUS				X			
D RMC-C STATUS	*						
E SEND INTERCOM MESSAGE				X			
F PRINT MODE		X			X		
G BELL STATE		X					
H TIME/DATE SET		X			X		
I TIME/DATE SYNC	**				X		
J TRANS LOG PRINT MODE	**						
K MODEM LOOP BACK TESTS	**			X			
N ACKNOWLEDGE ALARM							
O LOG OFF		X	X	X	X	X	X

* Equipment not installed at test site.

** RMMS I, J & K screens are not available at the FCPU